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THE CHAMBERLAND FILTER.

THE system of filtering illustrated herewith is an improvement upon the method used by Mr. Pasteur in his laboratory, and is due Mr. Chamberland, one of Mr. Pasteur's assistants. We have already described the simple form of the apparatus, which, it will be remembered, is affixed directly to the service pipe, and operates through the effect of the pressure existing in the mains. The porcelain cylinder through which the water filters is designated by the letter A (Fig. 1). It ends in an orifice, B, and is provided with a nut, C, which connects it with the metallic tube, D, with which it forms an annular space, F, which the impure water fills. Under a pressure of 2 atmospheres an apparatus of this kind, 8 inches in length by 1 inch in diameter, is capable of filtering 4½ gallons of water per day—a quantity that would appear to be sufficient for the ordinary needs of a household. The filter, moreover, may be unscrewed during the day, and the cock be used as usual, and then in the evening the filter may be replaced so as to operate during the night.

The unglazed porcelain used as a filtering material is baked at a very high temperature, so as to destroy every trace of organic matter that might exist in the paste, and to render the cylinder imputrescible. The product is entirely homogeneous, and the obtaining of the porosity that it possesses is the delicate point in the operation of manufacturing it. One of the great advantages of the Chamberland filter is the ease and quickness with which it may be cleaned. As the external surface only of the cylinder becomes soiled, it is only necessary, in order to clean it, to unscrew the nut, and take out the cylinder and brush it vigorously under a stream of water. For greater security, we may even immerse the entire cylinder in boiling water, or better still, heat it when dry in a gas flame or stove. By this process we burn all the organic matter that may have got into the interior of the cylinder.

Although this filter arrests all solid materials that are held in suspension in the water, it allows of the passage of the gases and saline matters that it holds in suspension, and that are not deleterious to health. When there is a necessity for a large quantity of water, the cylinders are combined in series of 3, 6, or 10, and are screwed into a drum which is affixed to the cock of the service pipe, and the filtered water from each of them collects in a receiving vessel. For the needs of hospitals, barracks, schools, and other large establishments, a form of the apparatus is constructed which contains 20 filtering cylinders. This consists (Fig. 2) of a metallic case connected above, through a cock, with the service pipe, and resting upon brackets through the intermedium of two trunnions. The lower plate is provided with 6 bolts, and 20 apertures into each of which is placed a cylinder with its rubber ring.

In order to mount the apparatus the case is tilted, and after the cylinders are put in, a plate is inserted which contains apertures for the reception of the tops of them. Before fastening the two plates, it is well to place a small rubber washer upon the ring of each cylinder. After this the case is righted and affixed to the cock. The filtered water is received in a funnel, from whence it makes its exit through an orifice beneath. The case is provided with a purge-cock, and a man-hole through which the pieces of a cylinder can be removed if one chances to get broken. This apparatus discharges from one to five pints per minute under a pressure of from two to three atmospheres.

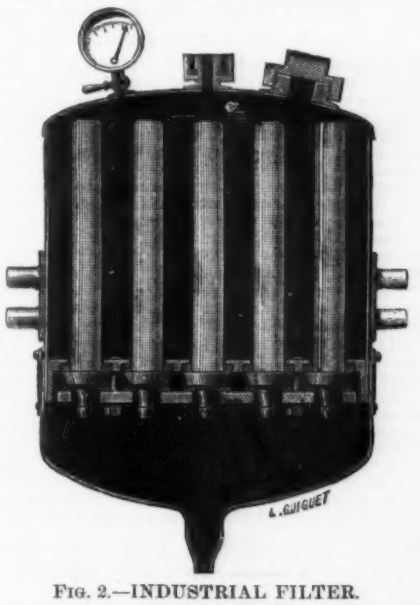


FIG. 2.—INDUSTRIAL FILTER.

All the apparatus just described operate through the effect of the natural pressure existing in the water mains. For use in places where there is no public water supply, the form shown in Fig. 3 has been devised.

This extremely simple apparatus consists of a cylinder, R, provided with a purge cock and having a capacity of about five and a half gallons. The bottom contains twenty apertures for the reception of as many cylinders. This receptacle fits into a reservoir, P, supported by three legs and provided with a cock. It suffices to put water into the upper receptacle, in order to obtain from nine to ten gallons per twenty-four hours.

This filter is particularly well adapted for country houses, villages, and wherever there is need of but a small quantity of water. As it may sometimes be necessary to have a greater discharge where there is no water pressure available, as on shipboard, in armies on a march, and in places where a large force of men are employed, the form shown in Fig. 4 has been devised. The apparatus is here portable, and can be carried by two men. The filter, which is the same as shown in Fig. 2, is connected by means of a rubber tube with a suction and force pump. With this apparatus there may be obtained 3½ to 4 pints of pure water per minute.

What we have said alludes to the filtration of water, but it is evident that the same process may be applied to the filtration of any other liquid, such as brandy, vinegar, and wine.—*Revue Industrielle.*

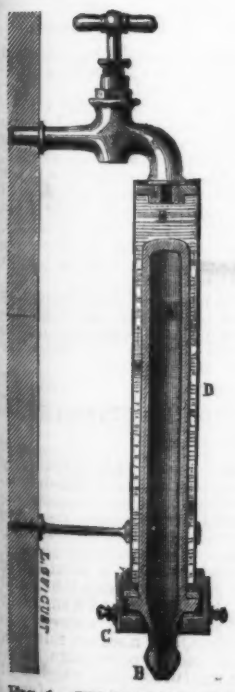


FIG. 1.—FILTERING CYLINDER.

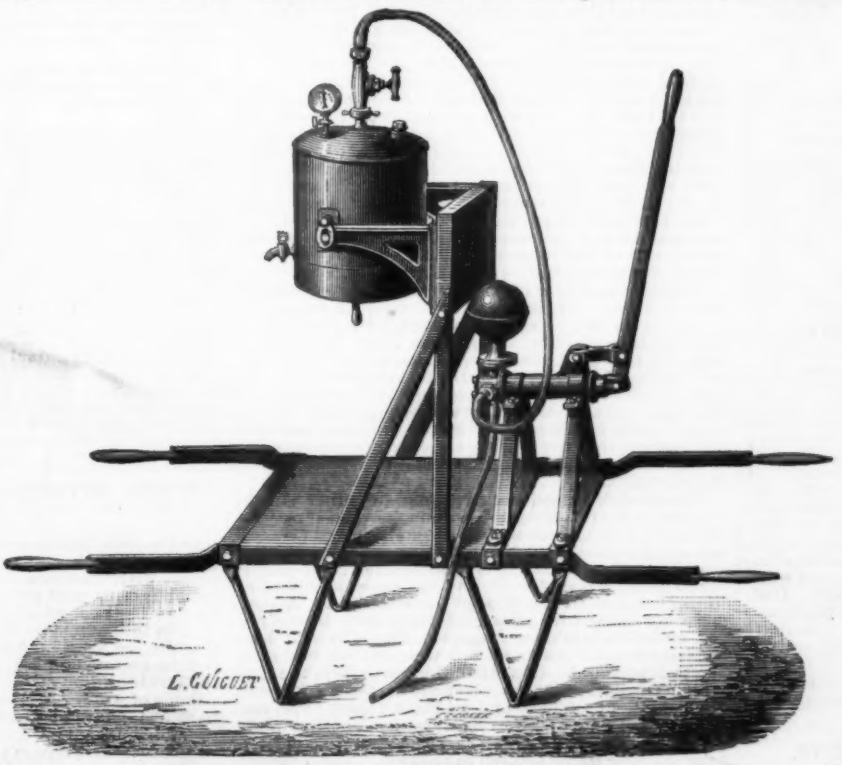


FIG. 4.—PORTABLE FILTER.

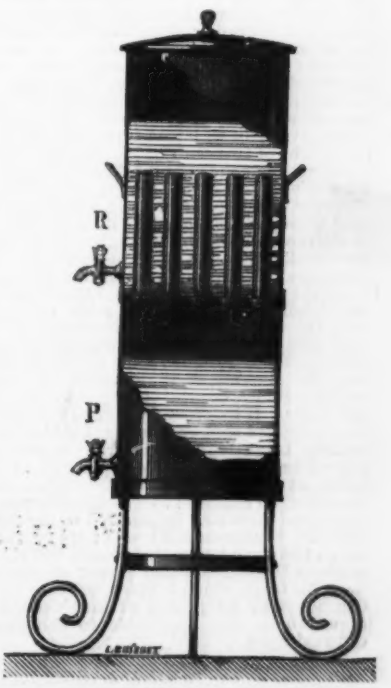


FIG. 3.—FILTER WITHOUT PRESSURE.

MICROSCOPIC GLEANINGS.

C. H. STOWELL.

Beads of Amphipleura.—Speaking of the photographs of this diatom made by Dr. Van Heurck, and of the discussion arising from the *beaded* appearance shown by the photograph, this journal says: "Thus in the case of the 'beads' of *A. pellucida*, the existence of such an image proves that the diatom has not merely a periodic differentiation of structure in one direction, but that such differentiation exists in two directions which cross at right angles." It says further that what the diffraction theory shows is that the *real* form and structure of the beads cannot be determined by the mere inspection through the microscope of their images. The microscope leaves undecided questions of elevation, depression, centers of thickening, etc.

Preparation of Spider.—The spinneret, leg, and falces having been removed from the spider are placed separately in liq. pot. for 24–36 hours; wash in water; place in acetic acid; soak in water; place in alcohol for short time; clear in oil of cloves; transfer to turpentine; mount "without pressure in cells." The tongue of the spider, carefully dissected out, makes a beautiful preparation. The eyes may be mounted in balsam, in cells, as opaque objects, with fine results.

Nothing New.—Mr. Crisp exhibited a microscope before the Royal Society made in 1686, which had a spring used for adjusting the focus of the lens, which spring "was the subject of a patent about fifteen years ago."

Sections of Hard Organized Substances.—The object (a piece of hard wood, for instance) is first filed level with an ordinary file and made more even with finer files. A piece is now cut off from that portion which has been filed smooth. The filed surface of this piece is now fastened to a slide with a drop of Canada balsam. Of course the object is pressed firmly to the slide, and the warm balsam allowed to get cold and hard. Then the section is filed until it is smooth and shining and transparent enough. After the final filing and polishing the section is cleaned with a cloth wet in alcohol, a drop of balsam added and the cover applied. "In this way ten or twelve sections can be prepared in a day."

Emerson as a Microscopist.—Dr. Oliver Wendell

Holmes mentions in his biography of Emerson, just published, that in 1833 Emerson visited Europe for the first time, and while there called upon Prof. Amici, who showed him his microscope, magnifying (it was said) two thousand diameters. Dr. Holmes says: "Emerson hardly knew his privilege; he may have been *the first American* to look through an immersion lens with the famous Modena philosopher."

Long Tubes.—W. J. Lancaster says we are to have a lengthening tube by all means. He has used tubes two feet in length with most excellent results, although all objectives will not stand it. One diaphragm should be used for about every nine inches of tube, otherwise internal reflections will spoil the definition.

Silicious Cement, for protecting corks from the fumes of acid, etc. Mix together equal parts of colloid silica and thick gum-water, with sufficient gilder's whiting to make it of the consistency of treacle.

For Labeling Slides.—A good plan is to punch some squares or circles out of very thin tale; cover the end of the glass slip with a thin layer of gilder's whiting and gum-water; when dry, write on this with common ink, let it dry, put a very small drop of Canada balsam upon it; cover with a circle of thin talc, and allow all to dry; then clean the edges with benzole and water mixed. It will not peel off or get dirty like printed labels.

Carbolic Acid Preservative, for animal and vegetable tissues.—Carbolic acid, 1 drachm; alcohol, 2 drachms; distilled water, 12 ounces; dissolve the carbolic acid with the alcohol, then add it to the water and boil it for ten minutes, and bottle for use.

Acetate of Aluminum.—To 1 part of acetate of aluminum, add 4 parts of distilled water. This is very good for preserving vegetable colors, as in the case of desmids and other algæ.

Glycerine and Acetic Acid is useful for mounting many minute insects and other objects; it is composed of glycerine, 1 ounce; acetic acid, ½ ounce.—*The Microscope.*

ROFESSOR LEONHARD WEBER'S PHOTOMETER.

By BOVERTON REDWOOD, F.C.S., F.I.C.*

THIS instrument consists essentially of two tubes attached at right angles, in the form of the letter T, in such a manner that, while one is supported in a horizontal position, the other can be placed horizontally or at any required angle. At the junction of the two tubes is a reflecting prism, by means of which, in combination with a diaphragm, the field of vision of an

observer looking into an eye-piece, which forms one end of the movable tube, is divided vertically into two equal portions. One-half of the field is illuminated by the light passing through the movable tube, and the other half by light passing through the fixed tube. The source of the light passing through the fixed tube is a small lamp burning petroleum spirit. This lamp furnishes the standard light, and a scale is attached to enable the observer to measure accurately the height of the flame. Inside the fixed tube, between the petroleum lamp and the reflecting prism, is a frame, carrying in a vertical position a circular plate of opal glass, and traveling along the tube, from end to end, by means of a rack and pinion. At one end of the movable tube (the other end being furnished, as described, with an eye-piece) is a holder, in which a rectangular plate of opal glass (or, if desired, two or more of such plates) is placed. The petroleum spirit lamp having been lighted, and the flame adjusted to the height of two centimeters, the light to be measured is placed at a convenient distance from the rectangular glass plate (usually 1 meter), and the eye of the observer being applied to the eye-piece, the traveling opal glass plate is moved by means of the milled head of the pinion until the two halves of the field of view are equally illuminated. The position of the traveling opal glass plate is then read off on the graduated scale attached to the fixed tube, and the illuminating power calculated by means of the table of values supplied with the apparatus. It is obvious that the traveling opal glass plate, being illuminated by the petroleum lamp, becomes itself, to some extent, a source of light; and the amount of illumination of one-half of the field, therefore, depends partly upon the proximity of this plate. If it is found that the light to be measured is so powerful that the standard side of the field is not equally brightly lighted, even when the traveling plate is brought as closely as possible to the reflecting prism, at the junction of the two tubes, the light may, of course, be removed to a greater distance, or a second opal glass plate may be inserted in the holder. Under ordinary circumstances both tubes of the photometer are in the same horizontal plane; but if it is desired to measure the illuminating power of angular rays, the movable tube, which is fitted with an arc divided into degrees, may be placed at any desired angle. The apparatus is also applicable to the measurement of diffused light.

* A communication to the Society of Chemical Industry.

HOW TO MOUNT LARGE INSECTS.

ROBERT GILLO gives his process for mounting beetles and other large insects, in the July number of the Journal of the Postal Microscopical Society. He procures, for instance, a common ground-beetle, perhaps half an inch long. This he places in a test-tube and adds *liquor potassæ*, full strength. Here it is steeped until the solution becomes darkened, when it is poured off and fresh added. Here it remains for ten days or two weeks, when the insect is carefully transferred to a dish filled with distilled water. With one camel's hair brush the insect is held steady, while with another brush the body is pressed upon with a kind of rolling motion, until the contents of the abdomen are driven out. The insect is now transferred to clean water, and left for an hour or so, when the squeezing process with the brushes is repeated. By repeating this process, the whole of the contents of the viscera can be removed without the least injury to any of the internal organs.

The insect is still opaque. It is, therefore, necessary to bleach it. For this purpose it is placed in the following solution, until sufficiently transparent, perhaps a week or more: Make a saturated solution of chlorate of potash, and add 10 to 20 drops, or more, of hydrochloric acid to each ounce of solution. The insect is then thoroughly washed in distilled water. Then place the insect on its back, in a china saucer, and arrange its legs, etc., as desired for mounting. Carefully pour over it alcohol, and be sure the legs are not displaced. After several hours, change the alcohol for fresh; and after several hours more, pass the insect into ether. After soaking some hours in the ether, pass into turpentine, where it can remain any length of time.

Make a glass cell slightly larger than the insect, but rather thinner than its thickest part. Arrange the insect, and fill the cell with balsam and benzole. The glass cell can be made of strips of glass without much trouble.

PHOTO-MICROGRAPHS ON GELATINE PLATES FOR LANTERN PROJECTION.*

By WM. H. WALMSLEY.

IT is generally admitted that a photograph of any object, animate or inanimate, in portraiture, landscape, architecture, or what you will, is a more literal transcript of the original than can possibly be made by the most skillful draughtsman, since nothing is left to the imagination. It this be true with objects visible to the unaided eye, how vastly superior in accuracy is the photograph of those requiring considerable magnifying power to render their structure visible? The most perfect drawing made under the camera lucida will be found more or less diagrammatic, while two or more drawings of the same subject, made by different artists of equal skill, will differ materially; each one penciling what he sees or thinks he sees. The sensitive plate, being incapable of feeling or thinking, records only the impression reflected upon it, and thus gives us an exact reproduction of the image formed by the lens.

The projecting lantern has been used for throwing transparencies upon a suitably prepared screen, but the subjects have usually been drawings, more or less diagrammatic and inaccurate. The desirability of using photographs made direct from the objects has been recognized, but the cost of the necessary apparatus, together with the time, labor, and skill required for its successful application, have prevented hitherto general adoption of this most perfect method of exhibiting a microscopical specimen to a class or audience of any kind.

The universal application and use of photography, however, brought about by the introduction of gelatine dry plates, has changed all this. The cost of the necessary apparatus has been reduced to a minimum, while its bulk and complexity have followed suit. The stains and disagreeable odors, attendant upon the old silver bath and collodion processes, have been consigned to oblivion. The prepared dry plates are furnished to us of uniform quality, by reliable makers, at extremely low prices, and the whole processes of making both negatives and positives may be pleasantly accomplished of a winter's evening, without even soiling one's fingers.

It is not my purpose, in this paper, to describe the process of making the negative. This I have already done on previous occasions; while other and abler pens have given us much practical information on the subject. I would merely premise that for the negative a plate of extreme sensitiveness and fine texture, developing with sharp contrasts and great density, is required, and that development with pyrogallic acid has in my hands given better results than that by ferrous oxalate. With such plates, powers ranging from four diameters to two thousand may be successfully employed with the light obtainable from a good coal oil lamp using one or two flat burners, while the simple and inexpensive camera shown upon the table, and which can be adapted to any microscope, is all sufficient for the production of the most perfect negatives by any process between the above extremes.

The gelatine plates for making the positives are of quite a different character to those used for negatives, being much less sensitive to light, and requiring a development which shall produce clear glass in the high lights, transparency in the shadows, and full detail in all portions. Two distinct kinds are now made, the one with a bromide of silver base, the other with a chloride. The latter is much slower than the former, requiring many times the length of exposure; but the transparency of the shadows is so much greater that I prefer to use them, and do not begrudge the extra time required.

Possessed of a good negative (and no other should be used, since it is not possible to make a good positive from a bad one), two methods of producing the latter are open to us—by contact printing or by the camera. The latter is undoubtedly the more perfect, and enables us to utilize a negative of any dimensions, enlarging or reducing it to the proper lantern slide. A deep printing frame with plate glass front must be employed, on which is laid the negative, film side *up;* upon which—film side *down*, so that the two shall be in contact—is placed the slow plate which is to form the positive. Of course this must be done in the dark room, by ruby light. A piece of dead black velvet, to prevent halation or any reflection from the back of the plate, must now be placed over the same, and the back of the printing frame secured in position. The exposure is made to the light of a coal oil lamp or gas jet, at a distance of about fifteen inches. If a *bromide* plate be employed, the length of exposure may vary from five to twenty seconds, according to density of the negative; if a chloride plate, however, be used, the time required may be as many minutes. No rule can be given, experience alone will enable one to determine with any certainty the length of time required, and just here some failures and disappointments may be expected. It may, however, aid some and not be amiss for me to say that for negative making I have found the "Diamond" plates by Richardson eminently satisfactory, while Carbutt's transparency plates, both bromide and chloride, leave little or nothing to be desired. They are cut from extremely thin and flat glass, so that when covered with a slip of the same thickness, and the edges neatly bound with needle paper, they present an exceedingly attractive appearance, and are very light in weight, fitting readily the cavities of any lantern in common use.

The development of the plate is of the utmost importance, since upon its success depends the beauty and perfection of the resulting transparency. The image should be sharp, clear, and transparent in the deepest shadows. Where clear glass appears, it must be absolutely so; the least smokiness or muddiness will spoil the brilliancy of the image upon the screen. The ferrous oxalate, made in the following simple manner, is entirely satisfactory when used with the Carbutt plates:

No. 1. Saturated solution neutral oxalate of potash.
No. 2. Saturated solution protosulphate of iron. To the latter add a few drops of a saturated solution of citric acid.

To make the developer, add one part of No. 2 to six parts of No. 1, and have ready a solution of bromide of ammonium for use in case of overexposure. This developer will be found to act very promptly, and to bring out all the details with proper density before those portions of the plate which have not been acted upon by light, and which should be clear glass, begin to show any signs of fog. If the plate we are using be one of the bromides, it will be well to continue the development until rather more density than is desired has been obtained, as it will lose somewhat in the subsequent fixing. If, on the contrary, we are using a chloride plate, the development must be stopped as soon as requisite density is reached, as it will lose nothing in fixing. The usual washing and fixing in the hypo bath, followed by an alum one, and prolonged washing to remove all traces of the hyposulphite of soda, must follow as a matter of course. Should the image flash up too suddenly, from overexposure, add a few drops of the bromide solution to prevent flatness and want of contrast in the image.

If the negative image be of larger dimensions than the lantern plate, and it be desired to place the whole thereof upon the latter, it will be necessary to employ some kind of a copying camera. One especially constituted for this purpose, with a double shifting front, capable of carrying one sized plate, will of course be found the best. In the absence of such, we may successfully use the same camera with which the negative was made, by removing the cone front and putting the negative in its place; which can readily be done by any one possessing a little patience and ingenuity. Then a board carrying a rectilinear lens of moderate focal length must be inserted in the central division of the bellows, and the front elevated toward the sky. An image of the exact size required may now be thrown upon the forming screen by withdrawing the front section of the bellows, carrying the lens to the proper distance, when it must be clamped, and the forming effected by the back bellows which carry ground glass screen. The plate holder containing one of the slow lantern plates is now to be substituted for the ground glass, and an exposure of five to twenty seconds made, governed by the density of the negative. The subsequent operations of development and fixing are precisely the same as those given for contact printing.

Should the resultant positive be lacking in density, or of a slaty hue and without crispiness, it may frequently be greatly improved by the following method:

After thorough washing to remove all traces of hypo, place it in a bath composed of:

Bichloride of mercury	96 grains.
Bromide of potassium	90 "
Distilled water	12 ounces.

This bath, it may be observed, should be returned to a well-stoppered bottle for future use, as it will retain its qualities for a very long period.

Its effect upon the gelatine film of the plate will be to bleach the same, but care must be exercised not to carry the bleaching too far, lest overdensity be the final result. Removed from this bath and well washed, it must be plunged into another consisting of a 12 per cent. solution of sulphate of soda, until the desired tone is reached. Almost any gradation of color from a light yellow brown to black, may be thus obtained, varied by the length of time immersion in the soda bath is continued. Final washing and drying must follow as in the original development.

When dry, the film is to be protected from injury by covering it with a thin plate of glass of the same dimensions as the slide, with a mat of paper cut out in suitable shape placed between the two, and the edges bound around with a strip of needle paper.

* A paper read before the Ann Arbor meeting of the American Association for the Advancement of Science, 1885.

RAPID DETERMINATION OF NITROGEN.

By A. HOUZEAU.

IN the soda-lime process the author has previously substituted a direct alkalimetric method which dispenses with standard solutions. After noticing the methods of Guyard and Ruffle, Mr. Houzeau describes his new method, which depends on the complete conversion into ammonia of fixed nitrogenous substances, if ignited at a red heat in contact with a mixture of sodium acetate and hyposulphite and soda-lime, and on the absorption of the ammoniacal gas in a sufficient volume of water. In practice it is merely necessary to have a standard acid, soda-lime, and a saline mixture, composed of sodium acetate and hyposulphite (thiosulphate). To prepare this mixture equal weights of the two salts are melted together in their water of crystallization. When cold, the saline mass is finely pulverized, and preserved in stoppered vessels. If the accidental presence of ammonia in these salts is suspected, one per cent. of solid caustic soda, free from niter, is introduced into the liquefied mixture. To effect the determination, about two grammes of the powdered saline mixture are first introduced into the bottom of the combustion tube (glass or iron), mixed with its own weight of coarsely powdered soda-lime, and upon that a stratum of a few centimeters of the same soda-lime unmixed. From 0·5 gramme to 10 or even 25

grammes (the latter weights in case of arable soils) are reduced to very fine powder, and intimately incorporated with 10 grammes or 15 c. c. (?) of the saline mixture, after which the whole is as intimately mixed with 10 grammes of soda lime in fine powder. The whole is introduced into the combustion tube, then filled up in the ordinary manner with soda-lime and a small stratum of broken glass. The combustion tube is heated from the front backward. The saline mixture placed at the back of the tube serves as a substitute for the oxalic acid or calcium oxalate generally used, and gives when ignited about 200 c. c. of inert gases, which rinse out the tube. In scientific determinations the ammoniacal gas is collected in the ordinary manner in a Will's bulb tube half filled with pure water colored with a few drops of neutral litmus. The neutralization of the ammonia is effected progressively in the bulb tube as it is produced by means of an upright Mohr's burette placed above the orifice of the exit tube, which must be straight. The mixture of the standard acid and the ammoniacal water is effected automatically by the escape of the gases. The standard acid is such that 1 c. c. represents 0·01 nitrogen, thus dispensing with calculation. In technical assays the bulb tube is dispensed with, and in its stead is used a simple escape tube, leading into a deciliter of water. Explosions have never occurred during the use of this method.

DETECTION OF NITRIC ACID IN AIR, WATER, AND SOILS.

By A. GRANDVAL and H. LAJOUX.

THIS process depends on the transformation of phenol into citric acid, and on the intensity of the coloration of ammonium picrate.

To determine a nitrate in solution, it is converted into ammonium picrate by the method indicated below, and the tint obtained is compared with that of a standard solution by means of a Duboscq colorimeter.

The process requires the use of a sulpho-phenic solution and of a standard solution of potassium nitrate. The sulpho-phenic reagent is prepared by mixing:

Pure phenol	3 parts.
Monohydrated sulphuric acid	37 "
	40 parts.

The standard solution of potassium nitrate contains per liter 0·936 grm. of this salt, a quantity corresponding to 0·50 grm. of nitric anhydride.

If we have to determine a pure nitrate dissolved in water, we pour into a porcelain capsule a volume, V, of this liquid, and evaporate it to dryness on the water bath. Let cool, and add to the residue an excess of the sulpho-phenic reagent, applying it by means of a stirrer over every part of the inside of the capsule, so that no part of the residue may escape the reaction. We add then a few c. c. of distilled water and then an excess of ammonia. We obtain thus a solution of ammonium picrate, which is diluted with distilled water so as to make up the original volume, V.

We operate in the same manner upon an equal volume of the standard solution of potassium nitrate, bringing the solution of picrate obtained to this volume. We then compare the two colored liquids by means of Duboscq's colorimeter.

Let H and H′ be the heights of the columns of liquid corresponding, the former to the liquid under analysis, and the latter to the standard nitrate. Let x be the weight of nitric acid sought, and p that contained in the volume, V, of the standard solution; we have then

$$(\alpha) \qquad \frac{x}{p} = \frac{H'}{H}$$

whence,

$$x = p\frac{H'}{H}.$$

It must be remarked that the difference in the proportion of nitric acid in the two liquids compared must not differ too widely, otherwise the two tints being too different, it might happen that one of the two scales of the instrument would not be extensive enough. Therefore, to dispense with trials, we prepare with solutions of potassium nitrate of different strengths colored solutions forming a scale of tints, among which we select that which approaches most closely to the tint obtained with the substance under analysis.

It is evident that it is not necessary for the volumes of the liquids to be equal. It may happen that the liquid obtained in the analysis has a color so faint that we cannot make up the volume, V, with the standard liquid. We then make of it a volume, v, and in that case the quantity of nitric acid is given by the formula:

$$(\beta) \qquad x = p\frac{H'}{H}\frac{V}{v}.$$

The numerous experiments which we have made prove that we may determine the nitric acid contained in a liquid with so close an approximation that we may feel certain at least of the fifth decimal. The process is applicable to very minute quantities, since we can determine the nitric acid contained in 1-40 c. c. of the normal liquid. This quantity being 0·0000125 grm., we have found 0·0000120 grm.—*Comptes Rendus.*

REDUCING PROPERTIES OF OXYGENATED WATER.

M. MARTINON.—The author studies the behavior of oxygenated water with manganese peroxide. The decomposition of the hydrogen peroxide is very complete in an acid solution, when there is formed a manganous salt with a rapid escape of oxygen. In a neutral or alkaline medium the manganese peroxide remains unaltered, and only 1 atom of oxygen escapes from each mol. of hydrogen peroxide. The author supposes it probable that the manganese peroxide is reduced in either case, but that in an alkaline liquid the manganese monoxide formed returns to the state of dinoxide by contact with the oxygen set free. With manganese sesquioxide in an acid liquid there is formed a salt of protoxide, and 2 atoms of oxygen escape. With potassium permanganate in an acid solution all the oxygen of the hydrogen peroxide escapes, and there is formed a manganous salt corresponding to the acid added. This reaction may be utilized for the determination of oxygenated water. We add, drop by drop, to 1 c. c. of the sample to be analyzed, diluted with 10 to 15 c. c. of distilled water, and strongly acidulated, a standard solution containing 5·659 of pure permanganate per liter. When the liquid begins to take a rose color, the number of c. c. decolorized indicates the volume of oxygen combined with the water. If, in a neutral or alkaline liquid, we add permanganate to oxygenated water, there is produced at first manganese sesquioxide; then this sesquioxide, in presence of alkaline oxygenated water, passes to the state of peroxide, and induces complete decomposition of the oxygenated water. If the oxygenated water is added to the permanganate there is decomposition, and formation of a brown precipitate of hydrated sesquioxide. If the solution of permanganate is dilute and alkaline, we observe, on the slow addition of oxygenated water, the formation of green manganate. In an acid solution with lead peroxide there is formed a salt of lead protoxide, and all the oxygen of hydrogen peroxide escapes. In an alkaline solution only 1 atom escapes, and the lead binoxide remains unaltered. Mercuric oxide is reduced only in an alkaline liquid, with formation of mercurous oxide.—*Chem. News.*

A CELLULAR STRUCTURE IN CAST STEEL.

By OSMOND and WORTH.

THE following experiments, which appear to throw some light upon the structure of steel, have been made in the laboratory of Creusot Works. Thin plates of annealed cast steel 0·02 to 0·03 millimeter thick, cemented to glass by Canada balsam, are slowly acted upon by dilute nitric acid in the cold. The iron is dissolved, leaving as a residue the nitrated derivate of a carbohydrate in a skeleton form corresponding to the original distribution of iron and carbon in the metal. Microscopic examination shows this distribution to be far from uniform, and that the steel is actually made up of small granules of soft iron separated from each other by partitions of another substance containing carbon, and which is a carbide of iron. In other words, cast steel may be said to possess a kind of cellular tissue, the iron forming the nucleus, and the carbide the envelope of the cell. The elementary cells so constituted, or simple cells, are aggregated in groups into so-called compound cells, which are divided from each other in the transparent sections by thin lines which are empty spaces. These lines form inclosed polygons which are of considerable size in cast steel, but become smaller, and more and more broken and confused in the metal that has been more or less perfectly forged. As the surfaces of the compound cells, after the action of acid, are represented in section by empty linear spaces, they must in reality be due to the contact of soft iron masses without the intervention of the carbide, in which case the compound cells are said to be deprived of envelopes. In another direction it is easy to see that the compound cells correspond to what is known as the grain of the steel, or their faces are regions of minimum cohesion, so that the fracture of a bar of steel may be defined as the surface which, in the particular part subjected to the cutting strain, contains the minimum of carbon. The observations apply only to cast steel that has been slowly cooled. By hardening the compound cells disappear entirely, the constituent elements remaining being simple cells, but the interposed carbide of iron is much less abundant than in the same steel when annealed; the remainder of the carbon having separated as hydrate, which appears to be uniformly dispersed or dissolved in the mass of the metal. From this point of view of these experiments, forging has nothing in common with tempering in modifying the structure of steel; although the change produced in physical properties is somewhat similar. The effect produced is in permanent deformation of the cells, the nucleus being elongated in the direction of the local flow with a more or less complete dislocation of the slightly malleable envelope.—*Comp. Rend.*

FOUNDATIONS OF ST. MARK'S, VENICE.

MR. C. H. BLACKWELL contributes to the last number of the *American Architect* an exceedingly interesting article upon a recent personal examination made into the foundations under the campanile of St. Mark's in Venice, from which we make the following abstract:

According to the best available authority, the foundations of the campanile date back to 888, though several centuries elapsed before the structure rose above the surface of the ground. It must have been finished before 1329, for in that year there is a record of the restoration of its top. It seems to have originally been surmounted by an open wooden loggia with a low pyramidal roof, which was frequently destroyed by fire and as often restored in some form of timber. In 1550, the present stone terminal features were built.

The entire height of the campanile, from the upper base course to the aureole of the angel's head which caps it, is 321·15 feet; the building is not perfectly plumb, it inclines slightly to the northeast. The horizontal dimensions at the base are 42·3 feet by 43·46 feet.

The most interesting features connected with this ancient structure lie underground, as the author well remarks. Mr. Blackwell figures the entire weight of the structure at 13,000 tons, in round numbers, and the distributed load on the piling at about six tons per square foot. Taking into consideration the treacherous nature of the soil upon which the building stands, and its area, it is one of the heaviest isolated structures in the world, and subjects the soil to a pressure that would well startle modern builders. The islands upon which Venice is built are composed principally of a mucky, alluvial clay, the upper layers looking like black mud; deeper down the clay becomes quite firm, but never as stiff as our blue clay. Under this clay stratum, which varies in thickness from a few inches to a hundred feet, is a bed of sand, full of water, and with practically no hard bottom.

A LOUIS XIV. CRADLE.

These being the conditions, Mr. Blackwell sought to know more about the foundations, and after much red-tape experience and strong indorsement, he obtained the requisite permission to start a hole at the corner of the campanile, and he thus records his results, but in fuller detail as to architectural features than we give them.

The pit uncovered about three and one-third feet face of the foundation. The foundation was found to be 15·67 feet deep from the pavement to the top of the timber; the material used was roughly dressed stone, being hard limestone, red Verona marble, trachyte, and the lowest course of all was green porphyry; some of this stone had evidently been used in previous structures, it being probably cheaper to rob an ancient building than transport the material from the mainland. The masonry was all laid in lime mortar of rather a poor quality; it was much disintegrated, due probably to the action of the sea water, which rises in this soil nearly to the level of the pavement; the work uncovered was well coursed with surfaces in contact more or less carefully dressed.

The foundation masonry rested directly upon a grillage of crossed timbers, each of the two layers being 4·72 in. thick; this grillage rested directly upon the heads of the piles. The piles are close together, and appeared to average 9½ inches in diameter at the head, but it was impossible to ascertain how deep they were driven. The timber in the piles was oak; and they were as sound and tough as sap-wood; the grillage was made of larch wood, similar to our yellow or hard pine. This grillage timber was so soaked with water and blackened by age that it was difficult to determine much about it; the outside could be broken off by the hand, but the inside was quite firm, especially so when we consider that it has been soaking for one thousand years, as the water circulates freely through these timbers. Around the outside of the base was found an extra row of piles without any load upon them at all; as the tops of these piles were exactly on a level with those under the mass, the tipping mentioned cannot be ascribed to any inequality in the settlement of the

piles, as the test pit was sunk on the low side. The author ascribes the trouble rather to a general movement in the earth, such as has elsewhere been observed in Venice and in the lower valley of the Po, where Roman pavements have been unearthed at a depth of as much as 25 feet below the present surface.

The superstructure of the tower is of brick, and the bricks used are very large, some of them measuring 17·6 × 12 × 3 inches. In referring to the load per square foot upon these foundations, the author suggests that the more probable function of the piles is to compact the mass of clay, the latter really carrying the load.

ON THE CONSTRUCTION OF ROLLING CAMS.

By Professor C. W. MacCord, Sc.D.

I.

Cams are defined by Prof. Rankine as being "those primary pieces, with curved acting surfaces, which work *in sliding contact* without being related to imaginary pitch surfaces, as the teeth of wheels and threads of screws are;" and Prof. Willis also classes them among the combinations whose action involves sliding. Nevertheless, the former writer in another place makes one exception to his definition, saying, "a pair of logarithmic spiral sectors may be used as *rolling cams*, to communicate by rolling contact an angular motion of limited extent, in the course of which it is desired that the velocity ratio shall vary between certain limits." We shall confine our attention to cams which thus work in pure rolling contact, and the object of this paper is to explain briefly the modes of constructing them, including a number which accomplish results not reached by the processes indicated by the authorities above quoted.

First, in relation to those of the logarithmic spiral form, Prof. Rankine says that "the only cases in which the dimensions and figures of such sectors can be determined by plane geometry alone, without the aid of calculation, are two, viz., when the two sectors are equal and similar, so that the sum of the greatest and least radii of each of the two sectors is equal to the line of centers, and when the combination consists of one sector working with a sliding bar or smooth rack."

The first of these cases is represented in Fig. 1. Let C, D, be the fixed axes of rotation, and let it be required that the rotation of one cam about C through a given angle shall cause the other to turn about D through the same angle. We may also assign one of the limits of variation in the velocity ratio, as $\frac{m}{n}$; then the cams are laid out thus: Divide CD at A into segments having the ratio of m to n, lay off the angles ACB, ADE, equal to each other and to the given angle, make CB equal to AD, and DE equal to AC, and draw the logarithmic spiral arcs AB, AE. It is clear that in this case the limiting values of the velocity ratio will be reciprocals of each other; in the present position we have:

$$\frac{\text{ang. vel. about C}}{\text{ang. vel. about D}} = \frac{AD}{AC},$$

and when B and E meet at G, we shall have:

$$\frac{\text{ang. vel. about C}}{\text{ang. vel. about D}} = \frac{GD}{GC} = \frac{AC}{AD}.$$

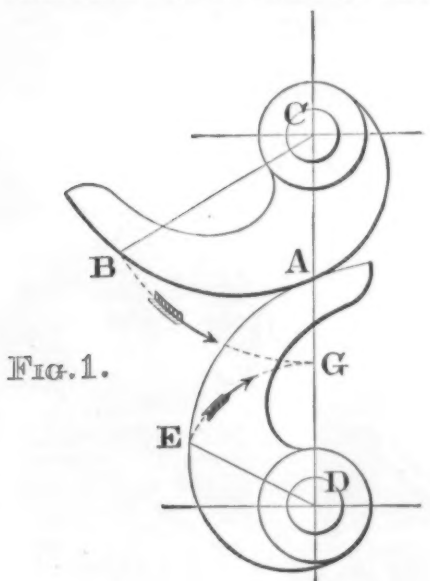


Fig. 1.

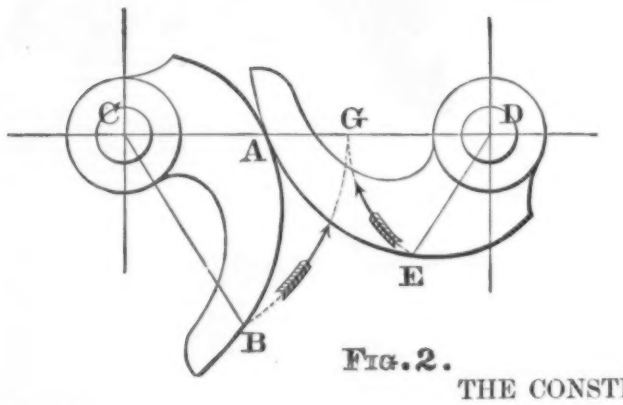


Fig. 2.

But it is not necessary that the two sectors shall be equal and similar, as stipulated by Professor Rankine in the above quotation. The conditions assigned may be varied, thus: let it be required that while one cam rotates through a given angle, the velocity ratio shall vary between two assigned limits not reciprocal, say $\frac{m}{n}, \frac{r}{s}$.

Then in Fig. 2 proceed as follows: Divide CD at A into two segments having the ratio of m to n, and at G into two others having the ratio of r to s; lay off GCB equal to the given angle, and make CB equal to CG. This gives two radiants CA, CB, and the pole C, from which the spiral arc AB may be constructed in the manner presently to be explained. The other sector is a portion of the same spiral reversed, of which D is the pole, AD is one radiant, and the other radiant is to be equal to GD; hence if the spiral be drawn indefinitely through A, and cut by a circular arc whose center is D and radius GD, the position of ED and the angular motion of the lower sector will be determined.

Fig. 3 illustrates the manner of constructing this spiral when the pole, and any two radiants with their included angles, are given, as they are in Figs. 1 and 2. The construction depends upon this property of the curve, viz., that the radiant which bisects the angle between two others is a mean proportional between those two. Thus, PK bisects the angle APH, and we have AP : PK :: PK : HP. Supposing, then, the two radiants AP, PH, and the angle APH to have been given, the point K on the curve would have been determined by drawing the bisector PK, and setting off upon it a distance equal to the mean proportional between the given radiants.

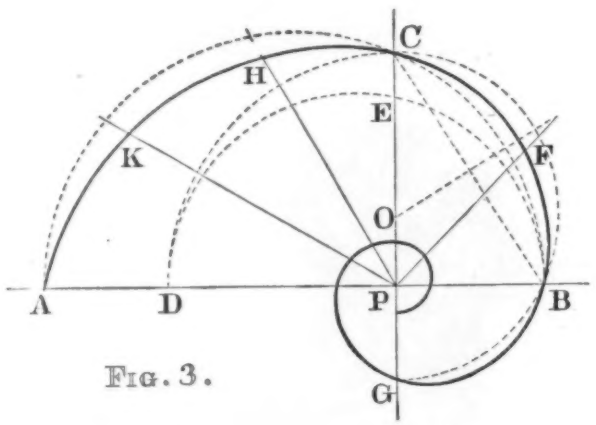


Fig. 3.

Suppose the two radiants given, to coincide in the same straight line, as AP, PB; then AB is a *diameter* of the curve, but the construction is the same. CP, perpendicular to AB, bisects the angle APB of 180°; and its length is determined by describing a semicircle upon AB as a diameter, cutting the perpendicular in C, a point on the curve. Proceed in like manner to find other points—for instance, set off toward A the distance PD=PC, and on DB as a diameter describe a semicircle cutting PC in E; bisect the angle CPB, and on the bisector set off PF=PE; then F is also a point on the spiral.

Upon the same principle the spiral can also be extended as far as desired. For instance, draw the chord CB, and bisect it by a perpendicular cutting CP in O; about center O describe a circle through C and B; it will cut CP produced in a point G which also lies on the spiral, since by this construction $PB^2 = CP \times PG$.

In Fig. 4, let AT be tangent to the spiral at A; then if the curve roll on the tangent, as indicated by the arrow R, the pole P will travel in the direction of the arrow S, describing the right line PB perpendicular to AP. Let AD upon the tangent be equal in length to the arc AC of the spiral; then when the rolling has brought the point C into coincidence with D, the radiant CP will have the position DB, parallel to AP.

This curve is called also the *equiangular* spiral, because the angle included between a tangent and a radiant is the same at every point in the curve. The tangent is evidently the acting face of the sliding bar called by Prof. Rankine a "smooth rack," and in order to determine the proper position for this rack, to work with a sector of a given spiral, it is necessary to find the angle which it makes with the radiant. In other words, to draw a tangent at a given point, to do which with absolute precision is impracticable without calculation; but a graphic process of sufficient accuracy for mechanical purposes is illustrated in Fig. 4. Suppose that it is required to draw at A a tangent to the given spiral, whose pole is P; draw PA, and prolong it to E, making PE equal to any other radiant PC, and through E draw EF, perpendicular to PE. With A as a center, and a radius equal to the length of the arc AC of the spiral, describe a circular arc cutting EF in D, then DA is the tangent required. In adopting this construction, the arc AC should not be great; the change in curvature is so gradual that if good judgment be exercised in fixing this length, this limited portion will vary almost inappreciably from a circular arc, whose center O may be found instrumentally by trial and error, after which the arc itself may be rectified by either of Prof. Rankine's familiar graphic processes. The results thus to be obtained are, if due care be used in the manipulation, close enough for all practical purposes, unless the arc AC be very flat; in which case the method of finding the center O shown in Fig. 5 may be used. Bisect the angle APC, and draw PV of indefinite length perpendicular to the bisector PD. Bisect the chord AC of the spiral by a perpendicular, cutting PV in O, the required center. This *circular* arc AC, it is to be observed, cuts PD in a point E, which also lies upon the spiral, since PE thus determined is a mean proportional between AP and CP; the approximation is therefore very close, if the arc be not of undue length, and should it be deemed desirable, may be made closer by bisecting the two angles EPA, EPC, and applying the above process to each.

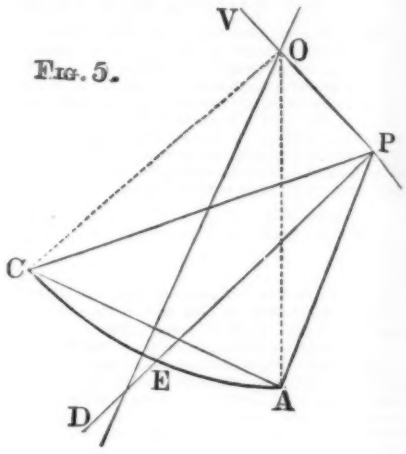


Fig. 5.

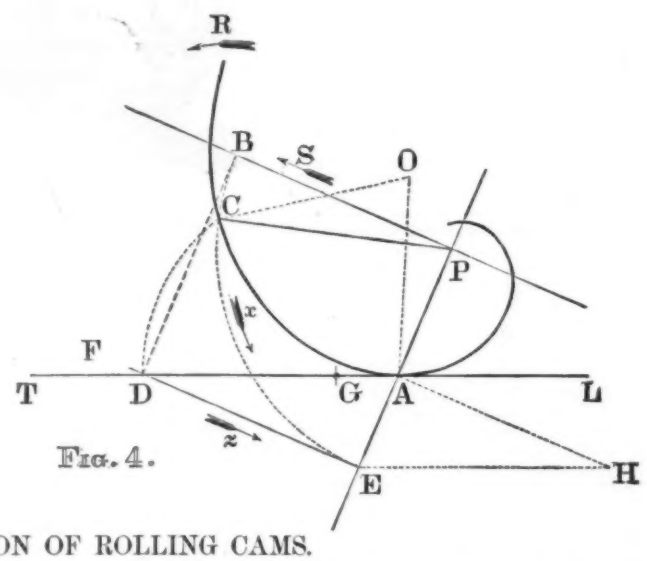


Fig. 4.

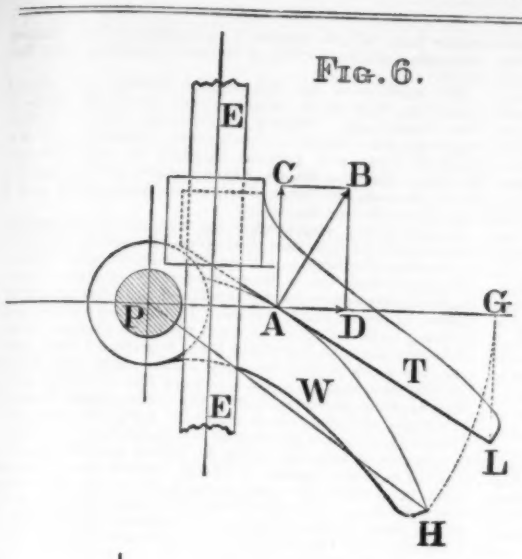
Should it be required to draw a logarithmic spiral of a given obliquity, it can be done with an equally close approximation to perfect accuracy, by reversing the construction of Fig. 4, with the aid of Prof. Rankine's graphic process, converse to the rectification of a circular arc.

Assuming any point P as the pole, and PA as one radiant; prolong PA, and set off PAE, the length of a second assumed radiant. Draw TAL, making the assigned angle with the radiant PA; draw also EF perpendicular to PE, cutting TL in D; then AD is the length of the arc of the spiral to be intercepted between the radiant PA and another whose length is PE, position yet unknown. On AD set off AG = ⅓ AD, then with center G and radius GD = ⅔ AD, describe an indefinite circular arc. Then the intersection of this arc with another one described about the pole P, with radius PE, will determine C, a point on the curve. We then have two radiants and their included angle, from which to find other points as in Fig. 3, or if a single circular arc be thought a sufficiently close approximation, we may find its center as in Fig. 5.

Now we have seen that if AC roll upon AD, the latter being stationary, CP comes eventually into coincidence with DB.

If instead of this we suppose the sector to turn about its pole as an axis, as shown by the arrow x, CP will at last coincide with EP. This rotation of the sector will push the smooth rack along, and in order to maintain pure rolling contact, the tangent must remain always parallel to itself, and its rectilinear motion must be such that while CP turns through the angle CPA, the point D of the rack shall go in a right line to the position E, as indicated by the arrow z, bringing the por-

FIG. 6.



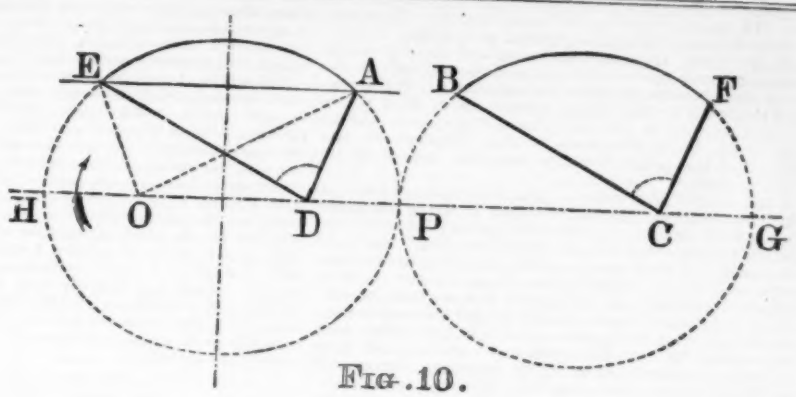


FIG. 10.

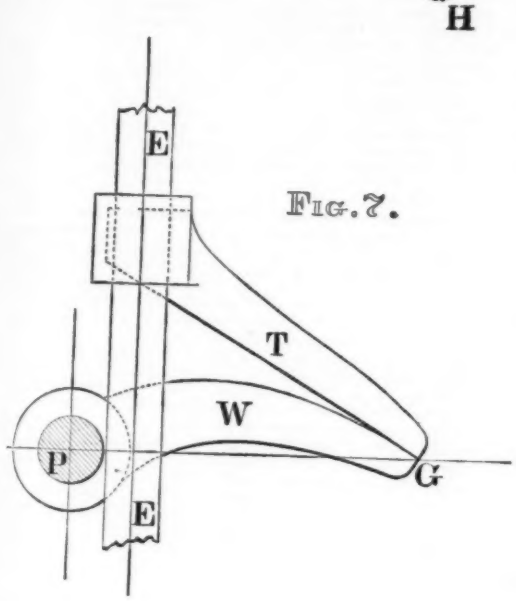


FIG. 7.

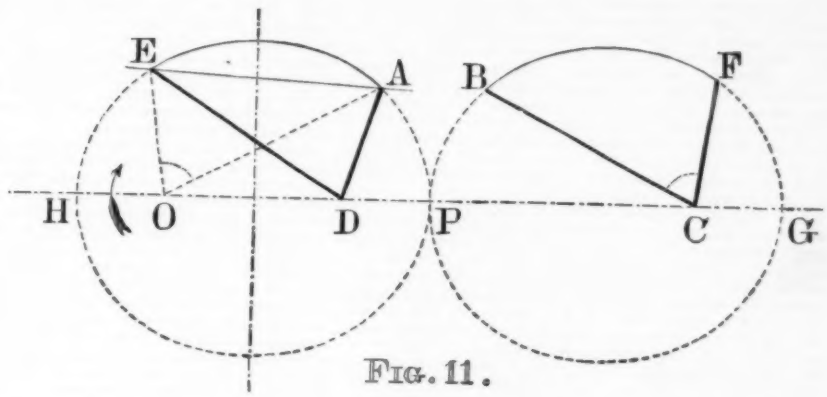


FIG. 11.

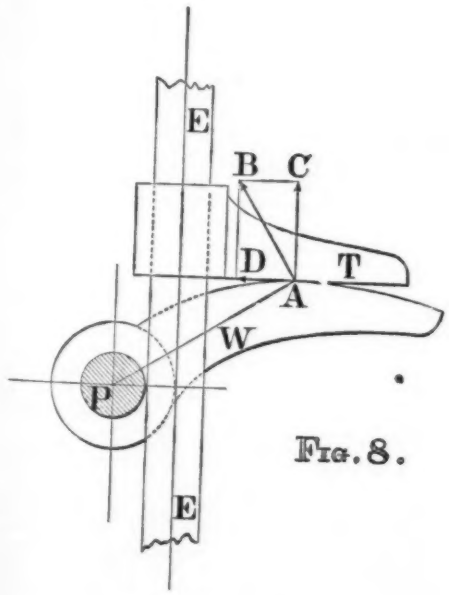


FIG. 8.

FIG. 13.

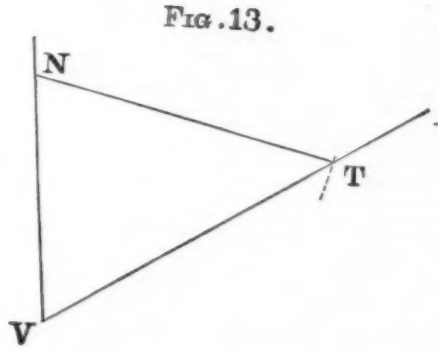
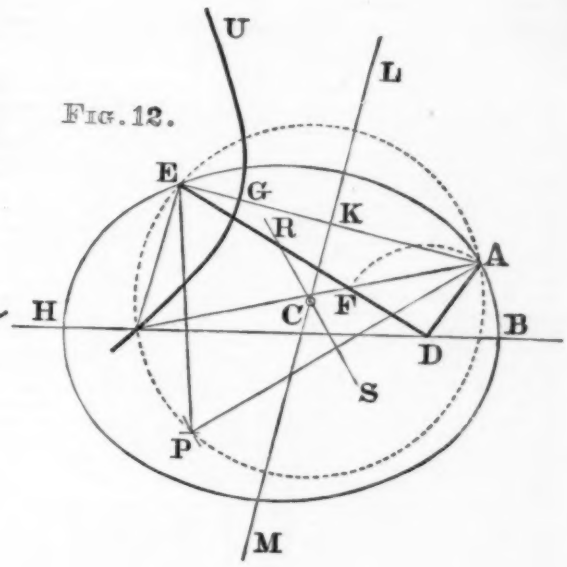


FIG. 12.



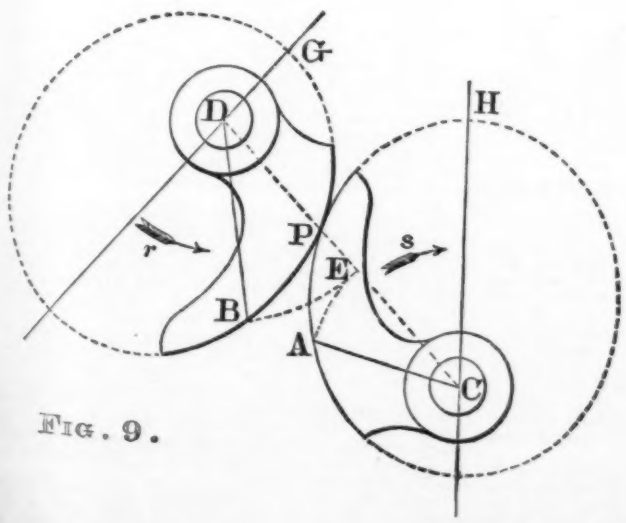


FIG. 9.

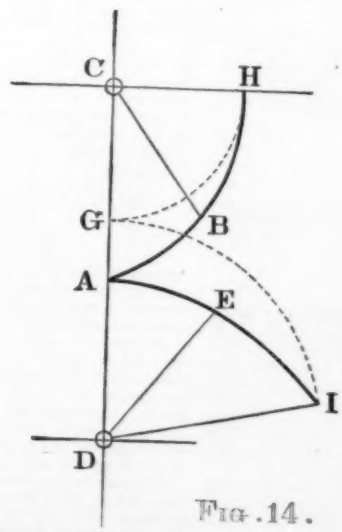


FIG. 14.

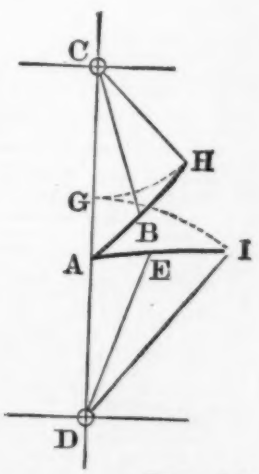


FIG. 15.

THE CONSTRUCTION OF ROLLING CAMS.

tion DA into the position EH parallel to TL. This may also be deduced from the general proposition that in rolling contact, the coincident points of the driver and follower must move in the same direction and at the same rate; thus for instance the extremity A of the contact radiant PA describing a circle about P, is at the instant moving in the direction AH perpendicular to PA, which must therefore be the direction of the motion of the point A of the tangent, and of all its other points.

Figs. 6 and 7 illustrate a practical arrangement of this combination, the cam or wiper W being the spiral sector APH, acting upon the lifting toe T, to raise the sliding rod EE; Fig. 6 shows the lowest, Fig. 7 the highest position of the toe and rod, the lift being the vertical distance LG. In regard to the action, we observe that if there be at the point of contact A a normal pressure equal to AB, this may be resolved into two components, one AC of direct lifting, the other AD producing side pressure of the rod EE against its guides and thus tending to cause friction This injurious component will become less as the angle DAL becomes more acute, but can never vanish, since at the limit the spiral becomes a right line. In that case the face of the toe would be perpendicular to the axis of the rod EE, and such toes can be and usually are so made, as shown in Fig. 8. But it is to be observed that when this is done, whether the wiper be of the form of this spiral, as in the figure, or of any other form, the action no longer consists of pure rolling contact. The motion AB of the contact point A of the wiper must be perpendicular to the contact radius PA, and it can be resolved into the components AC, AD; the former is that of direct lifting, but the latter is one of *sliding* between the wiper and the toe, which causes wear by abrasion, and tends thus to change the forms of the acting faces. In choosing between these two arrangements, then, the question is to be decided, whether this evil be greater or less than that due to the side pressure when the inclined toe and the rolling cam are employed.

But the logarithmic spiral is not the only curve which can be used, or accurately laid out by ordinary graphical operations. It is well known that two equal and similar ellipses are capable of working together in rolling contact, each rotating about one focus as a center, the distance between these fixed centers being equal to the major axis. And as shown in Fig. 9, portions of such ellipses may be employed as rolling cams, provided that the contact radius of the driver be always on the increase. Thus, DP is the least contact radius of the cam on the left, and that one will, clearly, if driven in the direction of the arrow *r*, compel the other to turn as indicated by the arrow *s*. In the position shown, the relative velocities are given by the expression:

$$\frac{\text{ang. vel. about D}}{\text{ang. vel. about C}} = \frac{PC}{PD};$$

and when B and A meet at E, we shall have:

$$\frac{\text{ang. vel. about D}}{\text{ang. vel. about C}} = \frac{AC}{BD}.$$

These elliptical sectors may be so proportioned that, as in the spiral cams shown in Fig. 1, they shall turn through equal angles, the velocity ratio varying between reciprocal limits. This will be seen by the aid of Fig. 10, in which the extremities of the major axes of the ellipses are in contact at P. Let the arcs PA, PB, HE, GF, be equal to each other, then the arcs AE, BF, will also be equal to each other, and will subtend equal angles at the fixed foci D, C; thus they will fulfill the above conditions. Drawing EA, it will be seen that it is perpendicular to and bisected by the minor axis; hence, if the angular motion and the values of the reciprocal limits be assigned, we have the following construction: assuming any point as one focus, make the angle EDA equal to the given angle, and on the including sides set off DA, DE, of magnitudes whose ratio equals that expressing one of the assigned limits of variation in angular velocity; join EA by a right line, and bisect it by a perpendicular, thus locating the minor axis. If the distance between the centers of rotation be also given, then the magnitudes of DA and DE are to be determined by dividing that distance into segments having the given ratio

Let O be the other focus of the left-hand ellipse in Fig. 10, and draw EO, AO. We then observe that the angles EOP, FCP, are equal to each other, and so too are the angles AOP, BCP. These equalities will hold good so long as the arcs HE, GF, are equal to each other, whether they are equal to PA, PB, or not. But if they are not, the angles EDA, BCF will no longer be equal, nor then will the radiants which include them. Consequently, the angular motions of the two sectors will be unequal, and the limits of variation in the velocity ratio will not be reciprocal.

This case is illustrated in Fig. 11, from a glance at which it will be seen that if the left-hand ellipse be turned about D as shown by the arrow, the other will be driven in the opposite direction; the action of the sectors will begin when A comes into coincidence with B, when the velocity ratio will be,

$$\frac{\text{ang. vel. about D}}{\text{ang. vel. about C}} = \frac{BC}{AD},$$

and will end when E and F come together, giving for the final velocity ratio:

$$\frac{\text{ang. vel. about D}}{\text{ang. vel. about C}} = \frac{FC}{ED}$$

The driving sector, then, turns through the angle ADE, while the follower turns through the angle BCF. Drawing EO, AO, these are respectively equal to FC, BC, and include the same angle. Now, supposing the distance between centers (or in other words the major axis), the non-reciprocal limits of variation in velocity ratio, and the angle through which one sector shall turn, to be assigned, we can from these data determine the eccentricity of the ellipse, construct the curves, and ascertain the angular motion of the other sector.

For dividing the given line of centers into two segments whose ratio is one of the limits, and again into two others whose ratio is the other limit, we would have, evidently, the lengths of AD, AO, ED, EO, in Fig. 11. Assuming then any point D as one focus, we construct the assigned angle EDA, included between sides whose lengths are now known; then with E and A as centers, and radii respectively equal to the other two known sides EO, AO, describe two circular arcs which will intersect each other in O, the other focus.

But again, it may be required that each sector shall turn through a definite angle, the precise values of the velocity ratio being unimportant; in this case the problem admits of many solutions. If the given angles be equal, the limits of variation will be reciprocal, and one may be assumed; the construction under these circumstances has already been explained in connection with Fig. 10. If, however, the angles be unequal, neither limit can be assigned to the velocity ratio, but the solution of the problem may be effected as in Fig. 12. Taking any point D as one focus, draw the lines DA, DE, of assumed lengths, including one of the assigned angles. Draw EA, and bisect it at K by the perpendicular LM; on DE set off DF=DA, and on EA set off toward E the distance KG=¼ FE. Then, since the other focus O when found must be so situated as to satisfy the equation

$$OA + AD = OE + ED$$

or

$$OA - OE = ED - AD,$$

it must lie upon the hyperbola OGU, whose focus is E, vertex G, and semi-transverse axis KG. Now in Fig. 13 draw two indefinite lines including at V the second given angle, and about any point N upon one of them describe with radius EA an arc cutting the other one in T Then in Fig. 12, with E and A as centers, and radii respectively equal to NV and TV, describe two circular arcs intersecting in P. Draw PE or PA, and bisect it by a perpendicular, as RS, cutting LM in C. Finally about C as a center, describe a circle through A, E, and P. This circle cuts the hyperbola in O, which will be the required second focus, since the angles EOA, EPA, will be equal.

It may be remarked that in this last construction, any two angles may be used which are to each other in the same ratio as those through which the sectors are required to turn; and the elliptical sectors thus constructed may be transformed into different curves, subtending the given angles, by a process illustrated in Figs. 14 and 15. Let AH, AI, be any two curves which will move in rolling contact about the fixed centers C and D, in Fig. 14; and in Fig. 15 let all the radiants be of the same length, but the angles included between them only half as great; then if we suppose these new curves to turn with the same angular velocities as the original ones, it is clear that H and I will meet at G in half the time, and the same is true of all intermediate points of the curves. The angles between the radiants may be expanded instead of contracted, and in any given ratio, the resulting curves rolling together with the same variations in velocity, but with different angular movements.

Now it is clear that although cams in general may not be related to imaginary pitch surfaces, these *rolling* cams are nothing else than the pitch surfaces themselves of portions at least of non-circular wheels, upon which teeth may be formed if desired. The effect of doing this would be to destroy the rolling action, and thus to sacrifice the advantage of freedom from friction. Nevertheless cases may arise in which, while it is necessary to employ a few teeth, they need not be carried along the whole of the acting outline. Thus, referring to Fig 9, it will be seen that if for any reason it had been desired to make use of those portions of the ellipses lying near the extremities GH of the major axes, the driving action could not there be maintained without teeth; and the same would hold true of curves derived from the ellipses, or those portions of them, by the above explained process of contracting or expanding the angles. It may be urged that these parts of the curves should not be made use of; nor should they if it can be avoided. But that this may not always be possible, will be seen from the following considerations.

There are four definite magnitudes to deal with, viz., the angles through which the two sectors must turn, and the initial and the final velocity ratio. If the angles are equal the velocity ratios are reciprocal, so that when one is assumed the other is known. If they are unequal, we have seen that if we assume one of them, and also the limiting values of the velocity ratio, we can construct the cams. But if both angles are given, it does not yet appear that the assumption of one velocity ratio gives sufficient data for determining either the obliquity of the spiral or the eccentricity of the ellipse; the construction illustrated in Fig. 12 involves, it is true, the assumption of the two angles, but neither velocity ratio can be given an assigned value in that manner except tentatively. Now, it may be that the requirements of the mechanism cannot be satisfied without having a fixed value for one of these limits of the velocity ratio, as well as for each angle of rotation. And in the succeeding article we propose to show how sectors satisfying those conditions can in certain cases be constructed from the ellipse, and the limits within which the assigned values must be confinen in order to make the construction possible. When that shall have been done, it will more clearly appear that under this new restriction it may be necessary to make use of curves whose action cannot be maintained without forming teeth upon some portions of their lengths, although they may be dispensed with upon other portions.

LOCOMOTIVE POWER, N. Y. ELEVATED RAILROAD TRAINS.

By Angus Sinclair.

So much has been said and written during the last year or two about the great expense of operating suburban railroad trains by steam locomotives, and about the economy that might be effected by the use of pneumatic motors, electric motors, and rope traction, that I determined, if possible, to make careful tests that would demonstrate exactly how wastefully or how economically steam locomotives performed work of this kind. Through the kindness of Col. Hain, general manager of the New York Elevated Railroads, I was recently permitted to make the desired tests, with Engine No. 2, running on the Third Avenue line.

The engine is of the Forney type, weighing, in working order, 21½ tons, and has been in service three months. The cylinders are 11 × 16 inches, and the driving wheels 42 inches diameter. The steam ports are ⅞ × 8 inches, and the exhaust ports 1¾ × 8 inches. The exhaust passes into a hemispherical receiver in the smoke-box, which contains a noise-muffler, thence through a single nozzle, 4 inches diameter, into the stack.

The work done by this engine during nine round trips from Harlem to South Ferry forms the basis of the calculutions. During two double trips, indicator diagrams were taken between most of the stations. Mr. John D. Campbell, general foreman of the Elevated Railroad Machine Shops, who arranged everything for the trial, took the cards during one round trip and I took them during the other.

A good many engineers who examine the diagrams will be surprised to find that so much work is expended in running the trains on the elevated railroads. Serious miscalculations have been made by engineers who ought to have been better informed as to the power required to move those trains. If the locomotive had nothing to do but get the train up to its average speed of fifteen miles an hour and keep it going at that velocity, the work would be very light. But that is not the way the work is done. During the run of 8¼ miles from Harlem to South Ferry, the train makes twenty-five stops, and the trip is made in forty-two minutes. The work done by the engine is a succession of twenty-five spurts, when the train is forced rapidly from a state of rest to a speed of about twenty-five miles an hour, then suddenly brought back to rest by the action of the brakes. The operation of the locomotive pulling one of these trains strikingly resembles the recurring work done by the engine of a pile-driving machine, which is constantly raising a heavy weight that is suddenly dropped and has to be raised again. If the Elevated Railroad trains were run through without making stops, they could be operated with a draw-bar tension of about eight or ten pounds per train ton, but the conditions under which they are moved require a draw-bar tension of about 40 pounds per train ton to be maintained while the engine is using steam.

Several writers who have lately been trying to instruct the public about how to operate suburban and city railroads economically, have fallen into the serious error of basing their calculations of train resistances on the traction needed for running trains through without stopping. In that way they obtained merely about one-seventh of the required power; and there is good reason to believe that parties are planning what they suppose to be improved methods for running trains, on the erroneous basis described.

The track throughout the whole length of the Third Avenue line is undulatory, with several grades over 100 ft. to the mile. There is less than one mile of level track on the whole line, and engines pulling trains do not here, as on a surface undulatory road, receive the benefit of the momentum gained going down a hill to help the train up the succeeding grade, for the stops are so frequent that all benefit from that source is lost.

Leaving Harlem, the track ascends 8 ft. per mile for half a mile, then descends 16 ft. to the mile for another half mile. Then comes an ascent of 105 ft. to the mile for 3,300 ft., which is succeeded by 1,500 ft. of a level, then 1,300 ft. of a descent at the rate of 95 ft. to the mile. Another short level is again reached, to be succeeded by an ascent of 100 ft. to the mile, followed shortly afterward by a descent of 80 ft. to the mile. So it goes all through the profile, a variety coming in when the lower part of the city is reached, in the shape of several very sharp curves.

The train pulled over this road consisted of four cars, which according to the official records of the road have an average weight of 23,850 pounds each. Taking the average load of passengers at 170 each, weighing 130 pounds, we have a total train weight, including engine, of about 80 tons to be moved. An examination of the indicator diagrams will show that the mean effective pressure in the cylinders was 81·5 pounds. According to the well-known formula $\frac{d^2 L p}{D} = T$, this gives a total tractive force of 3,759 pounds. Deducting 10 per cent. for loss from friction, we have 3,384 pounds remaining available for moving engine and train, a force a little over 42 pounds per gross ton.

The ordinary way of operating the locomotive is to start with the reverse lever in full gear, hook up, after about ten or twenty revolutions have been made, to the sixth or seventh notch, and get back to the eighth notch when full running speed is attained. The latter notch is seldom reached. The throttle is generally kept well out most of the time, so that there is little loss from throttling. All the diagrams except 4 and 6 were taken with the reverse lever in the seventh notch, where the average work of the engine is done. Cards 4 and 6 were taken in the eighth notch, the former on level track, the latter on a descending grade. These two diagrams show an excellent distribution of steam, and could the trains be run so that the average card would be of that character, few engines would do their work so economically as the locomotives on this road. The remaining diagrams were taken when the engine was doing its representative work forcing the train into speed, sometimes on grades, at other times on track nearly level. There was little difference in the character of the diagrams taken, whether on grade or level track, the difference alone being that in the latter case speed would increase quickly. On a grade a high steam line would be needed to keep up speed, while on a level the same high steam line would be used and the margin of power put into accelerating the velocity of the train.

The average horse-power developed, as shown by all the diagrams, was 81·7, which, for the two cylinders, makes 163·4 indicated horse-power. During the trip, occupying 42 minutes between the termini, the engine used steam only for 20 minutes. The average power therefore used in moving the train the whole distance would be $\frac{42}{20}$ of 163·4 = 77·8 horse-power. To move trains by continuous power, such as rope traction or electricity, would require the transmission from the power station of at least 77·8 horse-power for every train in motion. During commission hours, at present, there are sixty-three trains in motion on the Third Avenue line. This would require 4901·4 horse-power. The power now exerted moving the locomotives would do no more than cover the losses of transmission attending any other system.

During the day this engine made nine round trips, occupying 20 hours with waiting time, and in doing so used 42,959 pounds of water and 5,760 pounds of anthracite coal. There are exceptionally good means

of keeping an accurate account of coal and water used on the Elevated Railroad locomotives, and there is no doubt but these figures are more nearly correct than the particulars usually got from surface railroad tests. The coal consumption was reckoned from the time the banked fire was spread in the engine-house till the locomotive returned in the evening with as nearly as possible the same depth of fire made by the banking. No allowance is made for cleaning fires or for loss of heat while waiting for trains. There were 7·4 pounds of water evaporated from a tank temperature of 62 degrees Fahr. for every pound of coal consumed (making no deduction for a small quantity entrained), which indicated a particularly high boiler efficiency. The conditions of operating, however, prevent the engine from using the steam to good advantage. In the nine round trips run, steam was used for an aggregate time of six hours. Dividing the pounds of coal used by this time and the average indicated horse-power, we get 5·8 pounds of coal consumed per horse-power per hour. This makes no allowance for the losses of heat due to the great amount of running done without steam being used, or to that due to waste by the safety valve during detentions at terminal points or for the steam used in operating the brakes, which must have been considerable. Had the engine been permitted to run all its trips in close succession, and had the deductions been made for the losses referred to, the work of pulling the trains would probably have been done slightly under 5 pounds of coal per indicated horse-power.

With the terminal steam pressure so high as these small engines have to maintain it that the work required may be done, there is no opportunity to use steam economically, and no improvement can be effected unless heavier engines with larger cylinders are employed or a lighter load given them to pull, changes which in this case are inadmissible and are not advisable, since the achieving of any net economy would be by no means assured.—*National Car-Builder.*

GAS ENGINE ECONOMY.

IT may not be generally known to engineers that the gas engine is (when the percentage of heat utilized in the best engines is considered) a much more economical motor than the steam engine.

The gas engine, like the steam engine and hot air engine, is simply a heat engine—a machine through which heat energy is converted into the energy of motion. What, then, is its possible economy? Simply that percentage represented by the difference between the temperatures. The well-known formula applies: $\frac{T-T'}{T}$ = the possible duty, or, in plain words, the absolute temperature of combustion in the cylinder, less the absolute temperature of the surrounding atmosphere, divided by the absolute temperature of the combustion in the cylinder. The temperature of combustion in this instance corresponds to the temperature of the initial steam in a steam cylinder. That is the *possible*, or theoretical, duty. The practical economy in both the gas and steam engine is governed entirely by the terminal pressure and the amount of heat escaping through the cylinder walls; for "surrounding atmosphere," then, in the above explanatory clause, should be substituted "exhaust products," which it in fact comes down to.

In reference to a comparison between gas and steam, it may be well to recur to the present economy of the modern steam engine, and then give the best results which have so far been realized from the gas engine as at present constructed, without reference to its improvement in the future, which I shall refer to farther on. But what is the economy of the steam engine? That is a very difficult question to answer, especially when we consider both engine and boiler as one machine, which we shall have to do in making a comparison with the gas engine. Even engineers and mechanics of the highest reputation and varied experience, on this point widely differ; still, such men as Prof. Thurston, or Corliss, Porter, Emery, or Sims may be regarded as authorities in our own day as to economy of engines of the most modern type. There are so many different engines before the public that perhaps the most satisfactory way would be to accept the result of a test by good authority of some one engine of a popular class. In instituting a comparison with the gas engine, I should prefer to take one from that class of non-condensing, high-speed, automatic cut-off steam engines represented by such types as the "Porter-Allen" or the "Armington & Sims" or "Westinghouse." Of course, the automatic cut-off condensing engine (the "Corliss" being a good illustration of this class) or the compound condensing engine would show a higher duty, but they are in use principally for above 100 horse power, with which powers the gas engine is not yet in competition. In the test of an Armington & Sims engine, Prof. Thurston arrived at an approximate conclusion that its economy was equivalent to a consumption of 3 lb. of coal per indicated horse power per hour on a basis of a boiler estimate of 10 lb. of water evaporation to the pound of coal consumed. This engine may be fairly taken as an average of the class I allude to. Whether it can do better than that, or not as well, in general use, or whether there are others that can do better, I will not now raise the question; but for sake of comparison I will take the result reported as an average one.

Let us see now what the gas engine can do when using ordinary coal gas, or water-naphtha gas at average prices charged the public by gas manufacturing companies; then, what it can do where gas is obtained at net cost of manufacture. The gas engine as now built of most improved construction, employing compression before ignition in its cycle, and with sufficient expansion to reduce the terminal pressure to not more than 25 lb. above the atmosphere, will develop one indicated horse power to 20 ft. of coal-gas consumption per hour. Non-compression engines require considerably more gas. These facts I have verified by several careful tests. At the average prices charged for gas by gas manufacturers, this is above the cost of running steam engines for any except very small powers, unless the cost of attendance is reckoned into the account. In that case, as the gas engine requires no engineer, it is cheaper than the steam engine up to a limited range of power, and for some uses has great advantages over the steam engine on the score of convenience. In many cases, however, gas manufacturing companies make a special discount from their ordinary prices in its favor, which, of course, reduces the cost of running and increases its economy somewhat.

To give any facts as to the economy of the gas engine compared to the steam engine, when gas is furnished at its *actual cost* of manufacture, I shall have to refer to its use in England (and to English authorities), where its theory is much better understood, and where its manufacture has advanced to a much higher state of perfection than in our own country, and where it has as a natural sequence come into much more general use. In Europe gas engines are now supplied with self-starters, and are in successful operation up to as large as 100 horse power. In some cases they are "compounded," thus securing the fullest expansion; and in others are built double-acting.

Within the past two years there have been introduced in England, also, portable gas-making plants for making gas for single engines—some from oil and others from coal. The Dowson system, which has been adopted to some extent, consists of a portable closed furnace and coil boiler. Fire is kept up in the furnace by supplying coal through a check-valve door or opening (which connects the feeding box or supply holder with the furnace). Steam is generated and superheated in the coil by gas jets below, and the pressure (about 25 lb. per square inch) forces it into the furnace below the grate, and, on the injector principle, forces a quantity of air along with it. The usual reactions take place; the oxygen of the air and decomposed steam combines with the carbon of the coal, and the hydrogen is released. The composition of the gas is, approximately, hydrogen, 20 per cent.; carbonic oxide, 30 per cent.; carbonic acid, 3 per cent.; and 47 per cent. nitrogen. As stated by Mr. Dowson, a gallon of water and 12 lb. of anthracite coal produce 1,000 feet of this gas. Its net cost, including coal, attendance in making, interest on plant, etc., etc., with coal at $5 a ton, would be about *five cents a thousand feet.* At that rate, and by using five times as much as of coal gas to secure an explosive mixture (on account of the smaller proportion of hydrogen in it), a gas engine of 10 horse power would use 100 feet an hour per indicated horse power (or 1,000 feet an hour for a 10 horse power engine), which is equivalent to a cost of *half a cent per hour per indicated horse power.*

The tests made by Messrs. Crossley Bros., Manchester, England, of several "Otto" engines, and by Mr. D. K. Clark, engineer to the Smoke Abatement Committee (Manchester), show that the above economy was more than sustained. The two engines at Crossley's ran on Dowson gas thirty-five weeks, and gave an aggregate average of 150 indicated horse power, and the consumption of fuel was 1·3 lb. of coal per horse power per hour. Mr. Clark states the result of his tests to have been 1·4 lb. of coal per indicated horse power per hour. From another report of a local board of works at Edmonton, I see the result is stated to be 1·2 lb. of coal consumed per indicated horse power per hour. At $5 a ton of 2,000 lb., coal costs a quarter of a cent a pound. Taking the largest amount consumed at these tests, say 1½ lb. an hour, and the cost is three-eighths of a cent for one indicated horse power per hour—which is equivalent to three and three-quarters cents an hour for a 10 horse power engine, or thirty-seven and a half cents a day of ten hours' running. I will add that gas engines are now in general use in England as large as 50 horse-power, and that their economy, where gas is specially made for the purpose, will average not above half a cent an hour per indicated horse power.

With such results before us from the gas engine, as imperfect as it now is, what may we expect from it in its improved form? Even in Europe, where its best types are found, it has serious defects, which will be remedied. But little or no attempt has so far been made to improve its economy. Manufacturers have been content to commend it simply on the score of convenience, since there was a good demand for it because it *was* a gas engine. Its economy can and will be greatly improved. Its most serious defect on that point, as now constructed, is its wastefulness of heat. In the cycle of the gas engine, heat escapes and is lost: 1st, by conduction through and from the cylinder and all its parts; 2d, with the exhaust products, which are necessarily discharged at a much higher temperature than the surrounding atmosphere.

How can these losses be avoided? is the practical question. The use of a water jacket increases the loss of heat by conduction, as it is then simply absorbed by the water; and the cooler the water is kept, the greater is the loss of heat. But the water jacket is a necessity in the compression gas engine, in order to keep the heat down to a point that the piston can be lubricated, and compression before ignition is now recognized as the first requisite to economy. To keep the cylinder, then, at a temperature of not below boiling water may be fixed as the limit of economy on that score, at least for the present.

The difference of temperatures between that of the exhaust products and that of the surrounding atmosphere represents the loss of heat which escapes with the exhaust; and this loss is very large, in the best type of gas engines of the present day—fully equal to 20 per cent. of the heat evolved in the cylinder, which is more than the total available heat utilized in the modern steam engine cylinder. How can this escaping and wasted heat or any portion of it be saved? This question early came home to Watt in his study of the steam engine, over a hundred years ago, and the result was greater expansion (or "compounding"), and the condenser, which reduce this loss to the minimum.

This method of economy, however, cannot be applied to the gas engine. But the greater heat of the combustion in a gas engine over the heat of steam, and the consequent excess of difference in temperatures of gas over steam between the initial and terminal pressures, is largely in favor of the gas engine, and more than makes up for its excessive loss of heat with the exhaust, even as at present constructed.

Although the condenser cannot be made use of, yet it is entirely practicable to save a good portion of the exhaust heat, by utilizing it to heat the compressed charge before ignition. How much can be saved in this way is simply a matter of mechanical appliances. If one-half only is saved, and the heat of the exhaust products is reduced to one-half what it otherwise would be, a largely increased economy would be at once realized, equal to 10 to 12 per cent. of the available heat, and over 50 per cent. increase in the present average economy.

By a similar contrivance to the regenerating plates of the hot-air engine as now built, or by passing the hot exhaust in tubes through the incoming compressed charge, one-half of the waste exhaust heat can be easily utilized, and possibly very considerably more.

It is calculated that the loss of heat through the cylinder walls and water jacket of the gas engine is about 50 per cent. of the heat evolved. Deducting this and the exhaust and radiation waste, and we have a net utilization of 20 per cent. of the heat energy of the fuel (gas); which, although less than it ought to be, and much less than it will be in the future, is at least 7 per cent. better than the best type of steam engines, and probably 10 per cent. to 15 per cent. better than the average. Of course, I consider in this approximate comparison the loss of heat through the boiler of the steam engine in converting water into steam, which great waste never can be avoided. With large gas engines of upward of 25 horse power, the percentage of loss through the cylinder walls is considerably less, and the economy, of course, correspondingly larger.

The gas engine in America is yet crude. The largest number of those now built do not even employ compression, which is the most important adjunct to their economy; the waste products are allowed to mix with the new charge, thus retarding combustion; and the regulation of speed is confined to the number of explosions entirely—methods, all of them, which ought to have been dropped several years ago. No attempt has been made to introduce portable gas-making plants, as in Europe, and which eventually will be required for sizes above 5 or 10 horse power, in order to compete with steam; and self-starters, which are so common across the Atlantic, are as yet unknown here.

The gas engine is indeed yet in its infancy; still, it is popular, and its convenience has brought it largely into use. The attention of engineers is now being directed to improving it, and when even a part of the defects I have named are corrected, which they very soon will be, we may expect to see the engine very much advanced in economy, and within a short time a very strong and successful competitor of the steam engine.

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THE POST OFFICE IN THE TIME OF WASHINGTON.*

"ON the resignation of Samuel Osgood in 1791, the office of Postmaster-General was bestowed on Timothy Pickering. So insignificant was the place, and so light the duties that officer was to perform, that Washington did not think him worthy of a cabinet seat. Yet there is now no other department of government in which the people take so lively an interest as in that over which the Postmaster-General presides. The number of men who care whether the Indians get their blankets and their rations on the frontier, whether one company or two are stationed at Fort Dodge, whether there is a fleet of gunboats in the Mediterranean Sea, is extremely small. But the sun never sets without millions upon millions of our citizens intrusting to the mails letters and postal cards, money orders and packages, in the safe and speedy delivery of which they are deeply concerned. The growth of the Post Office in the last ninety years is indeed amazing. In 1792 there were two hundred and sixty-four post offices in the country; now there are forty-nine thousand. The yearly revenue which they yielded then was twenty-five thousand dollars; now it is far above forty-five millions. More time was then consumed in carrying letters ninety miles than now suffices to carry them one thousand. The postage required to send a letter from New York to Savannah was precisely eighteen times as great as will now send one far beyond the Rocky Mountains, into regions of which our ancestors had never heard.

"With newspapers the Postmaster-General would have nothing to do. The postmasters in the towns and villages did, indeed, receive them and send them on with the mails, but they were under no obligation to do so. It is, therefore, a common thing to read, in the papers printed at towns remote from the seaboard, complaints that the Pennsylvania packets or the New York journals were kept back, and civil requests to the postmasters to let them come on. When they did come, it was usually in saddle bags, and, as the riders never traveled by night, they were several days old. From the official post office notices in the newspapers, it appears that letters which went out from Philadelphia at eight and a half in the morning of Monday were expected to reach New York at two in the afternoon of Tuesday. Precisely the same number of hours was spent on the road from Philadelphia to Baltimore. Under the confederation this pace was thought speedy enough; but times had changed. A new government had been set up; the debt had been funded; the bank had been established. A wild desire to speculate had taken hold upon men, and, in their anxiety to hear of the doings of Congress and the price of stocks in the neighboring cities, a post that made ninety miles in twenty-nine hours and a half seemed insufferably slow. An attempt was therefore made to hasten the mails, and Jefferson, at the suggestion of Washington, had a long conference with Pickering. The wish of the President was that letters should travel one hundred miles in twenty-four hours. The plan was to have the pouches carried by the riders in the day and by the coaches during night; but the country was too poor. An attempt had, indeed, been made in New Jersey to run mail coaches with seats for four passengers; but that State laid a yearly tax of four hundred dollars on stages and taverns, declared the Federal Government was no better than an individual, and demanded payment. In Maryland and Virginia the right to convey passengers had been granted as a monopoly to certain men. When, therefore, the motion was made in Congress that all stage wagons of the post office should have the right to carry passengers too, a cry went up that such a law would be a violation of State rights, and the motion was lost.

"Another motion, however, was more successful. In-

* From the second volume of Prof. McMaster's "History of the People of the United States." New York: D. Appleton & Co.

deed, it became a law, and for nearly a half century controlled the affairs of the Post Office. The act, as it passed from the President, fixed the rates of postage, gave the franking privilege to Congressmen and heads of departments, and made newspapers mail matter. The postage on a letter was six cents for any distance not greater than thirty miles. This limit passed, it grew rapidly, till it stood at twenty-two cents for four hundred and fifty miles; beyond that twenty-five cents were exacted. In passing by sea from port to port the charge was eight cents. These rates applied only to single letters, and by a single letter was meant one written on a single sheet of paper, however large or small. Two sheets made a double letter; three sheets a triple. Packets, however, went by weight, each ounce avoirdupois costing as much money as four single letters. No postmaster in future, it was further decreed, should receive or distribute newspapers free of postage, and the postage was to be one cent a paper for any distance to a hundred miles; after that the rate became a cent and a half. In the House the franking privilege and the powers of the Postmaster-General provoked a warm debate. Among the people little notice was taken of any part of the bill save the newspaper clause. One grumbler declared that it would now cost more to send a paper from Portland or Savannah to Philadelphia than to bring it over from London, and in support of his statement quoted Pickering. A Postmaster-General of our time would scarcely feel called on to defend the justice of an Act of Congress, or to reply to all the slurs cast on his department by the press; but it was not thought so then, and Pickering, after the manner of his age, replied. He called his critic a liar, who lied because it was natural to him and he could not help it, and then gave some facts and statistics which are both curious and valuable. The greatest mass of newspapers that had ever in any one week been lodged in the post office by the Philadelphia printers weighed two hundred and forty-two pounds. No count had been made, but, as the papers always came wet, it was safe to take the weight of each at one ounce, and hence the number at three thousand eight hundred and seventy-two. During the same week one thousand one hundred and forty newspapers came into the city from all parts of the country, some to stay, some to pass through. The whole number of copies of newspapers printed in the United States in a year might, he said, be liberally estimated at four millions and a half. Of these not above one-ninth, or five hundred thousand copies, would ever find their way to the post office. It seemed quite reasonable that one hundred and fifty thousand of these might be assumed to pay a cent and a half, the remainder paying one cent; the gross revenue would probably be five thousand seven hundred and fifty dollars. The net revenue would be one-half that sum, for the other half was to go to the postmasters for their trouble in taking and delivering papers and collecting postage. To talk about the princely income the government would receive was, therefore, absurd.

"But the grumblers were not to be persuaded that the measure was a wise one. It was, they said, a vile tax on knowledge. The business of a newspaper was to spread information, and that kind of information which was most valuable in a republic, information regarding the doings of Government. Men who dwelt far from the seat of Congress had come to look upon the gazettes and journals as their only means of knowing what steps were being taken to protect the frontier, to pay the public debt, to encourage arts and commerce. When, however, to the eight dollars a year paid to the printer was added the four dollars and sixty-eight cents they must pay to the postmaster, poverty would force them, loath as they were, to withdraw their subscriptions. Then Government, removed from their searching gaze, would make inroads on their liberties and sport with their dearest rights. Nay, this had already been done. What else was the franking privilege but an aristocratic distinction? Why should the mass of the people be loaded with an odious tax while a select few escaped? Was the information likely to be conveyed in the letters of Congressmen better than the information to be found in the packets and journals? What kind of information did these letters convey while the funding system was being framed? Had not these self-appointed aristocrats most shamefully abused their privilege on that occasion? Had they not by their franked letters sent and gathered news from all parts of the country for nothing, which, had their constituents sought it, would have cost great sums of money? And now they had the face to gloss over the newspaper postage with the name of revenue! That scheme of finance which collected a revenue from the mails by loading them with free letters might be understood by the mind of a Congressman, but, happily, such minds were rare.

"The long list of newspapers which our ancestors feared would be cut down in circulation by the new postal law is well worthy of examination. Of the packets and journals, gazettes and sentinels, there contained, not one came out on Sunday. No religious paper, no scientific paper, no illustrated paper, nor one which, in our time, would be called a literary or a trade journal, appears in the list. Yet it would be erroneous to suppose that the newspapers had not made great progress in the seven years of peace. A few that witnessed the revolution had indeed ceased to exist. But their places were more than filled by others which sprang up in every part of the Union. Towns once content to read such packets and courants as came by the post-boy now boasted of mirrors and oracles of their own. At Falmouth, in Maine, at Northampton, in Massachusetts, at Harrisburg, at Pittsburg, and far down the Ohio, where, ten years before, the country was a wilderness, rude presses had been set up and newspapers appeared. In the East two journals of enterprise put forth issues each day. The attempt was a bold one. News was hard to gather. The presses were so rude that the best workmen could turn off no more than two hundred copies in an hour. The cost of paper was high, and no newspaper had yet reached thirty-six hundred subscribers.

"Six years before the war but two paper mills could be found in New England. One was at Norwich, in Connecticut; the other was at Milton, whence a bell-cart went out each month to collect rags at Marblehead and Salem, at Providence and Newburg, at Charlestown and Boston. When the war opened, the supply of paper from England ceased, and the forty mills in the United States were unable to supply the demand. Rags could not be gathered. Again and again the newspapers were forced to suspend. The printer of the Connecticut *Courant* in desperation started a paper mill of his own. The Massachusetts *Spy* besought "the fair daughters of Liberty" to save every scrap of rag and send it to some paper mill. Still they did not come in fast enough, and the newspapers were compelled to become gatherers for the mills. Indeed, to the close of the century, and even later, it is hardly possible to look over the four stiff, blue pages of a country newspaper without meeting with an offer of the printer to buy old rags. Under this stimulus the mills increased rapidly in number. When 1797 came, there were sixteen in Connecticut. They would employ, it was proudly said, one hundred and sixty hands, and consume three hundred and twenty tons of rags each year. Taking the number of families in the State at thirty thousand, each should, therefore, furnish its quota of twenty-four pounds. It was earnestly hoped that every man would say to his wife, "Molly, make a rag-bag and hang it under the shelf where the big Bible lies." Another paper wished that every child should be taught his "rag-lesson." When the first paper mill west of the mountains was set up, like appeals went forth repeatedly to the public.

"Something, however, had been gained by the new postal law. Newspapers had at last become mailable. They would no longer be dependent for circulation on the pleasure of the post-rider. But the law said nothing about books or magazines; the Postmaster-General refused to have them enter the mails, and, in consequence, one of the best magazines of that time was forced to suspend.

"When the 'American Museum, or Repository of Ancient and Modern Fugitive Pieces, Prose and Poetical' expired, there were but two older periodicals left in the country. Indeed, when the first number appeared, in January, 1787, two rivals were all it encountered. One was printed at Boston; the other, and unquestionably the better of the two, the 'Columbian Magazine,' had been started four months earlier at Philadelphia. 'The Universal Asylum and Columbian Magazine,' conducted 'by a Society of Gentlemen,' was remarkable for the variety and the excellence of the copper plates which 'embellished' its pages. Yet neither it, nor its fellows, have any resemblance to a modern monthly magazine. The custom, now so common, of preparing a November number for the press in the middle of July, and issuing it in the middle of October, was unknown. Those for November came out in December, and the same contributions often appeared in several. Each had a 'Parnassiad' of 'selected poetry,' generally odes to Laura; selections from the writings of Colonel Humphreys and Philip Freneau; epigrams, epitaphs, songs translated from the French, and, at times, a few lines from Homer. There were 'Political Speculations,' in which were 'Remarks on the Conduct of Spain with Respect to the Mississippi' and 'Considerations on the Best Interests of the United States.' There were 'Public Papers' and 'Physical Papers,' giving some 'account of a horse with a living snake in its eye' and 'The True Nature and Cause of the Tails of Comets.' There was a chronicle of foreign and domestic news, 'Satiricals' on old bachelors, old maids, and married men; reports of law-cases; now and then an 'impartial review' of such a novel as 'Modern Chivalry' or such a book of travels as Bertram wrote; long biographies and long laments over the degeneracy of the time. Nor were 'Rural Concerns' forgotten. Farmers were given 'hints,' and instructed as to the culture of Tartary oats and the use of plaster of Paris for manure. The back of the title page was often used by the printer to acknowledge the verses of J. H., to regret that the paper of Americus could not be used, or to beg Baltimorean not 'to pester' him with any more 'collections,' as the postage on each was twenty-five cents.

"Between 1786 and 1792, ten magazines sprung up. Some struggled on for a few years, but more quickly perished. In 1792 a 'Ladies' Magazine' was begun, with a preface of that kind of fulsome flattery it was the fashion for women to receive. When the century closed, the first religious magazine, the first 'Review,' and the first political monthly were begun. Long before that day, however, books and pamphlets were admitted to the mails.

"The act of 1792 expired by limitation on June first, 1794. Some changes were then made. Carriers were to be employed in the great cities, and two cents paid them for every letter delivered. On such as by written request were held at the office, one cent was charged. Postage on a single newspaper going to any town in the State wherein it was printed was reduced to one cent. When the size of the mail and the mode of conveyance would permit, magazines and pamphlets might be taken. The rate was one cent a sheet for fifty miles or less, half as much more for the next fifty miles, and ten cents when the distance was over one hundred. Had the 'American Museum' been in existence, the postage on the thirteen sheets which made each monthly number would, at New York, have been twenty cents."

SICKNESS AND SEA AIR.

SEA air, says a writer in the *Fortnightly Review*, is useful in almost all cases of chronic disease, and especially in those of tedious convalescence. When, however, the digestive and assimilative functions are very weak, the result is often not satisfactory, inasmuch as waste of the body is promoted, while a corresponding amount of new material fails to be assimilated. Under such circumstances a preliminary sojourn for a short period in pure country air is advisable.

Bathing in the open air is potent either for good or evil, according to circumstances, yet it too often happens that baths are taken even by delicate persons without proper advice. As Dr. Weber points out, warm sea baths are generally indulged in more on the prompting of the inclination than under competent advice. He adds that "infinite advantages might be derived from them, either alone or combined with the internal use of water. Many invalids would gain more from such a plan properly carried out than from a visit to a Continental spa." It certainly seems strange, adds the writer, that whereas advice is always sought before taking baths at Continental bathing places, where perhaps the water contains only a small proportion of saline matter, and differs but little from that of an ordinary warm bath, courses of warm sea water baths in England are often taken by invalids of all kinds without any advice, and with blind confidence in the suitableness of the water to all conditions. Sea air is especially beneficial in scrofula, in bronchitis, in many cases of rheumatism, in gout, and in most cases of consumption. The increased temperature plays an important part in the alleviation of many of these diseases.

PROGRESS OF TELEPHONE LITIGATIONS.

THE patent of Professor Alexander Graham Bell, granted March 7, 1876, and which is alleged to cover all known forms of the electric speaking telephone, has been a fruitful source of litigation in the courts for the past seven years. Notwithstanding the fact that this patent has several times been sustained by the United States Courts, the tide of litigation still flows on, and Mr. Bell's claim to have been the first and original inventor of the speaking telephone will undoubtedly continue to be challenged until the United States Supreme Court shall have fully and finally passed upon that question.

Two of the cases which have been decided in Mr. Bell's favor—the Dolbear case, decided by Judge Gray and Judge Lowell, and the Molecular case, decided by Judge Wallace—have been appealed to the Supreme Court, but have not yet been reached.

Recently the telephone litigation has assumed a new phase, a suit having been instituted by the United States Government against the American Bell Telephone Company et al. in the United States Circuit Court, in the Western District of Tennessee, to recall, repeal, and annul the patent of Mr. Bell numbered 174,465, of the date above stated.

This case naturally excites a good deal of interest among electricians and inventors, on account of the enormous interests involved and the novelty of the procedure. We therefore purpose to lay before our readers some of the facts relating to this suit, in order that they may understand the issues involved therein.

The bill of complaint was filed on the petition of Watson Van Benthuysen, of New Orleans; Charles P. Huntington, of Mississippi; J. R. Beckwith, of New Orleans; and George Gantt and Casey Young and others, of Memphis, Tennessee; the permission to file it was granted by the Department of Justice at Washington, D. C., after investigation; Messrs. J. R. Beckwith, George Gantt, Hon. Casey Young, and General Wright, of Memphis, were appointed special government attorneys to assist in prosecuting the suit.

Mr. Beckwith has been, and we believe now is, counsel for the National Improved Telephone Company; Mr. Gantt and General Wright were counsel for the Pan-Electric Company; and the Hon. Casey Young was secretary and treasurer of the Pan Electric Company.

The articles of incorporation of the Pan Electric Company were filed at Nashville, Tennessee, October 30, 1883, and were signed by five persons only, and they contain this paragraph:

"That the amount of capital stock of the same is five million dollars, and is divided into fifty thousand shares, and the par value of each share is one hundred dollars, and the following are the names and places of residence of the shareholders, and the number of shares held by each of them respectively:

J. Harris Rogers, of the city of New York	10,000 shares.
Joseph E. Johnston, of the city of Washington, D. C.	10,000 "
Isham C. Harris, of the city of Memphis	10,000 "
Augustus H. Garland, of Little Rock, Ark.	10,000 "
Robert F. Looney, of Tennessee	10,000 "

And we do certify that such association will commence its operations the first day of November next, and that it will terminate on the first day of November in the year 1933.

"Witness our hands and seals this 27th day of October, 1883. J. Harris Rogers, J. E. Johnston, Isham C. Harris, A. H. Garland, R. F. Looney."

The Republic, a periodical published in Washington city, has had for many months, and had last week, among its advertisements a list of the directors of the Pan Electric Company, and A. H. Garland is named as one of them.

Whether Mr. Garland now has any interest in the Pan Electric Company, we of course do not know.

In 1884 the Pan Electric Telephone Company made an agreement with one of its directors, J. Harris Rogers, that he should get up a company to use the Pan Electric style of telephones in Pennsylvania. That agreement contained the following:

"It is further agreed that in the event of any judicial proceeding being commenced against the said party of the second part, or said corporation when organized, on the ground that said patents infringe any older patent or other invention, the said party of the first part agrees to defend such suit with its own attorney, and at its own expense; and if said party of the second part should be enjoined or restrained from the use of said instruments by the order or decree of any court, the royalty upon such instruments shall cease for and during such time as their use is so prohibited."

In November, 1884, the Bell Telephone Company brought a suit against the Pennsylvania Rogers Company, and the Pan Electric Company, in the United States Circuit Court at Philadelphia for infringement. The Pan Electric Company did not defend the suit, but asked the Court to rule that they were not properly served, and could not be compelled to defend in that district; and the Court so ruled. The Rogers Company, which the Pan Electric Company had agreed to defend, made no defense, and a final decree was rendered against it.

Afterward the Bell Company brought suit in Baltimore, in the United States Circuit, against the Washington Telephone Company, which used the Pan electric telephones there, and against the Pan Electric Telephone Company itself. The Pan Electric Company did not appear, but the Washington Company did, and after some time had been allowed, it was unable to get the case ready to argue, and urged that the fact that a suit had been brought by the United States at Memphis ought to be enough to induce the Court not to grant any injunction nor have any hearing on the subject. It would seem, therefore, that one purpose which those who filed this bill had was by its mere pendency to prevent the granting of any injunction under the Bell patent. The Circuit Court at Baltimore declined to take that view of it, and gave the defense time to prepare their case, but issued in the mean time a restraining order forbidding the company putting out any more telephones until the motion had been heard.

In 1884 the National Improved Telephone Company of New Orleans made a contract with some people in Pittsburg that they should get up a company there to use the National Improved Company's style of telephone, and that contract contained the following:

"In case of any litigation involving the validity of said Letters Patent, or any of them, wherein the said Western Pennsylvania Telegraph and Telephone Company shall be a party defendant, said National Im-

gored Telephone Company shall have prompt notice thereof, and shall assume the control of said litigation, and at its option be made a party thereto at its own expense."

"It is further understood and agreed that the sum of five thousand dollars shall, upon the delivery of this instrument in writing, be deposited in the Allegheny National Bank of Pittsburg by the National Improved Telephone Company, and shall not be used except for the purpose of payment of the expenses of any litigation which may arise within the period of twelve months from the date hereof."

The Bell Company sued the Pittsburg Company, and after a good many postponements a motion for an injunction was argued before Judge McKennan and Judge Acheson at Pittsburg last July. They granted it upon the ground that the Bell patent had been sustained by all the courts, and that those decisions were perfectly fair and ought to be followed, and that the defendents did not have any really new defense.

It thus appears that the Department of Justice has specially appointed as counsel in the suit to annul the Bell patent those who have been counsel for the Pan Electric and National Improved Telephone Companies.

Suits to repeal and annul letters patent of the United States for inventions and discoveries in the useful arts have rarely been instituted by the Government. We now call to mind but one reported case in which a patent for an invention or discovery has been vacated and set aside by the court on a bill in equity filed by the United States for that purpose. That is the case of the United States *v.* Gunning and another, recently decided in the Southern District of New York, which is reported in 23 Federal Reporter, 653.

In United States *v.* Gunning, the defendants demurred to the Bill of Complaint, assigning as cause therefor that the Government could not maintain a suit in equity to vacate letters patent for an invention, although the patent was obtained by fraud, and in support of the demurrer cited the opinion of Judge Shepley in Attorney General *v.* Rumford Chemical Works, 2 Banning and Arden, 298.

Judge Wallace, however, overruled the demurrer, deciding that a bill in equity is an appropriate remedy in behalf of the United States when a patent for an invention has been obtained by fraud.

Subsequently, and in December, 1884, the same cause went to final hearing and was decided by the United States Circuit Court in the Southern District of New York, upon pleadings and proofs taken and filed on behalf of the Government. No proofs whatever were taken or filed by the defendants, they relying solely upon the denials contained in their answer to the bill. In an opinion delivered in that case by Judge Wheeler, the Court says: "In analogy to the requirements of evidence for defeating patents and for setting aside or reforming solemn written instruments generally, it would seem that the substance of the allegations should be established by full proof adequate for the removal of all fair doubt. On the evidence, however, it seems to be quite clear that Gunning was not an original inventor at all of the invention. It appears to have been shown to him by others, some time before his application, and that he did not then claim to have known of it before. This might be so, and he have invented it before that; but he has not shown by others nor testified himself that he had, and the circumstances strongly point to the conclusion that he had not, that he knew that he had not, and that he was not the first nor an original inventor even, follows of course. This conclusion is too strong to be resisted, and this point seems to have been made out beyond a fair doubt." A decree was made setting aside this patent. It is therefore clear that a patent cannot be set aside upon the ground of fraud unless the fraud is made manifest beyond a reasonable doubt, and that conjecture or suspicion cannot be substituted for proof.

In the case of the United States against Fraser, 22 Fed. Rep., page 106, the United States Court at Chicago decided that the Government had no authority to bring a suit merely for the benefit of private parties, who had an opportunity to try the question whether the patent was valid in suits of their own.

From a careful examination of the Bill of Complaint in this suit of the United States *v.* The American Bell Telephone Company *et al.*, it appears that the issues raised by the bill and the principal grounds therein urged against the validity of the Bell patent of March 7, 1876, are in substance the same as those which have been involved and are now in controversy in other cases pending in the United States Circuit Courts. It is however true that in the suit instituted by the Government to vacate Mr. Bell's patent, the question of its fraudulent and improper issue may be and is more sharply raised than in any of the previous cases. This is so, because in a suit brought by the Government to set aside a patent for fraud, the Court may go behind the face of the patent and look into the proceedings had before the Patent Office. Among other grounds alleged for vacating and repealing the Bell patent, it is stated in the Bill that the Examiner, Z. F. Wilber, who had charge of Bell's application, was ignorant of the science of electricity and magnetism, and that by reason thereof Bell cunningly and wrongfully concealed from the Examiner, and the Patent Office, the state of the art, and so adroitly framed his specification and claims as to make it appear that the invention related simply, and only, to an improvement in telegraphy. It is also averred that the Examiner wrongfully gave Bell information of matters contained in Gray's caveat, whereby Bell was enabled to obtain undue advantage of Gray, and to defeat him in any future effort to obtain letters patent for the invention described therein.

The defense that Gray was a prior inventor to Bell, and that Bell surreptitiously and unjustly obtained a patent for that which Gray, McDonough, Drawbaugh, and others had invented and discovered, and which invention they were using due diligence in perfecting, has already been interposed in several cases, and has heretofore been overruled by the Circuit Courts; and inasmuch as the United States Patent Office and the Circuit Courts have held that there is nothing in the prior state of the art anticipating Bell's patent, it must be assumed, until the contrary is decided, that no error was committed by the Patent Office in granting Bell's patent on the 7th of March, 1876.

The affidavit made by Mr. Z F. Wilber, upon which the National Improved Telephone Company and the Pan Electric Company in part base their proceedings to set aside the Bell patent, states among other things that on the 19th day of February, 1876, Messrs. Pollock and Bailey, Bell's attorneys, were notified that the first, fourth, and fifth clauses of claims in Bell's application related to matters described in a pending caveat; that on the 24th day of February, 1876, Bell's attorneys addressed a letter to the Commissioner of Patents, wherein they stated that they had "inquired the dates of filing of the caveat, inasmuch as we are entitled to the knowledge," and protested against the delay which the notice to the caveator would subject Bell, and that thereupon they made a special application to the Commissioner of Patents, under whose instruction the Examiner withdrew the suspension of Bell's application. Mr. Wilber, the then Examiner in the Class of Electricity, now says that after having carefully examined the patent law then in force, he is satisfied that Mr. Bell's attorneys were not entitled to the notice given, and that the ascertainment of the date of filing Gray's caveat was contrary to law; but he admits that at the time the proceedings were had it was a custom in the Patent Office to give such information to applicants for patents.

Mr. Wilber is not now an Examiner in the Patent Office.

In the "Drawbaugh case," Mr. Bell was interrogated concerning his knowledge of Gray's caveat at the time he filed his application for letters patent, and while the same was pending in the Patent Office; and in answer to a cross-interrogatory he testified as follows: "When I found that my application was in interference with some other application filed in the Patent Office, I went to Washington to examine into the matter, for I understood that an applicant in interference had a right to see that portion of the interfering application which conflicted with his invention. I therefore went to the Patent Office, and requested the Examiner to explain to me the exact points of interference between my application and the other. I found that there had been two interferences declared with my application. The first was with a caveat filed the same day as my application, and had already been dissolved. The Examiner declined to show me the caveat, as it was a confidential document, but he indicated to me a particular clause in my application with which it had conflicted. I therefore knew it had something to do with the vibration of a wire in liquid. I do not now remember what it was that led me to suppose that this liquid was water."

In answer to another cross-interrogatory, Mr. Bell also testified: "Q. You mean to be understood, I suppose, that you did not see either the description or the drawings making part of that caveat, or any part of that description or the drawings? A. I do." And further on in his examination he stated that the Examiner simply pointed to a clause in his application, and informed him that the caveat had interfered with that; and that the clause was a passage in the body of his application referring to the vibration of a conducting wire in mercury or other liquid.

What importance the Court will attach to the irregularities charged to have been committed by the Patent Office at the time of the grant of Bell's patent, we may not now suggest. Suffice it to say that, as we understand Mr. Gray's status as an inventor, he only claims to antedate Bell in that he was the first to construct and use an apparatus by which composite tones could be transmitted and reproduced. In a letter addressed to Bell, dated March 5, 1877, Gray says: "I gave you full credit for the *talking* feature of the telephone, as you may have seen in the Associated Press dispatch that was sent to all the papers in the country, in my lecture in McCormack Hall, February 27. Of course you had no means of knowing what I had done in the matter of transmitting vocal sounds. When, however, you see the specification, you will see that the fundamental principles are contained therein. I do not, however, claim even the credit of inventing it, as I do not believe a mere description of an idea that has never been *reduced to practice*—in the strict sense of that phrase—should be dignified with the name of invention."

The only amendments which were made by Bell to his specification after the filing thereof are contained in that part of his patent in which he points out the distinction between intermittent, pulsatory, and undulatory currents. It would thus appear that no amendment was made by Bell in that part of his specification which is alleged to describe a liquid transmitter, after the filing of his application.

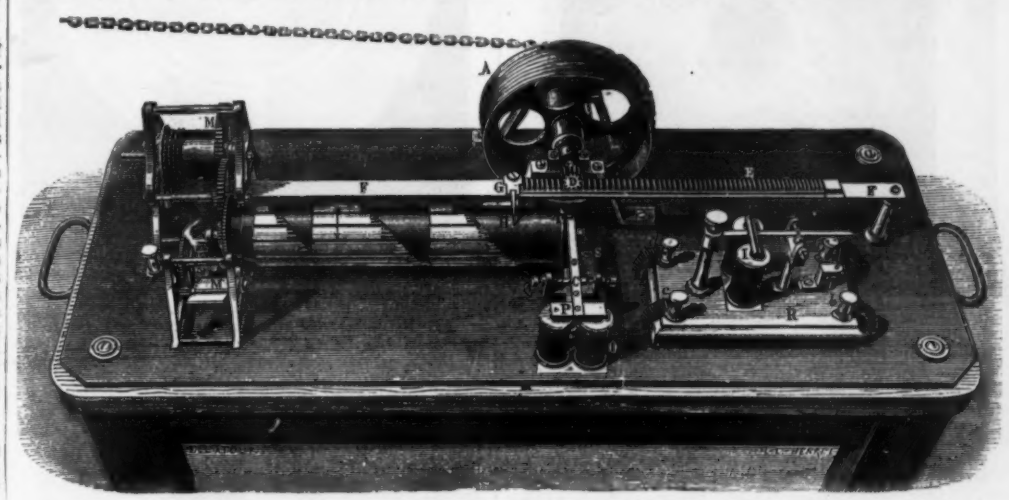
Looking over the telephone controversy with an impartail eye, it seems to us that the chief benefit which is likely to accrue to inventors and to the public, so far as the suit instituted by the Government is concerned, is not that any novel or startling facts will thereby be disclosed, but that by reason of the ample resources of the Government the case may be thoroughly tried, and all the issues involved therein brought to a speedy and final determination.

We trust that the rule of *comity*, which has obtained in previous cases, will not be followed in the Government suit, if its attorneys can show that any prior decree was collusively obtained, or if it shall be made manifest that some new and important fact or legal principle has previously been overlooked by the courts. Nevertheless, it is well to remember that the rule of comity is a wise and wholesome one when rightly administered, as public interests are generally best subserved by adhering to decided cases, and not agitating matters which have once been established.

RAVAGLIA'S HYDROMETROGRAPH.

THE apparatus which are used for automatically indicating variations in the level of water in rivers, canals, or reservoirs are of different constructions, but may be reduced to two principal types, according as they are diagram or dial instruments. These hydrometrographs present the inconvenience of requiring an office designed to receive their indications. They cannot be connected with a telegraph line. My hydrometrograph, on the contrary, operates like an automatic telegraph instrument, and sends dispatches in Morse characters, any time that it is desired, to any station whatever. To effect this, the apparatus is connected with the nearest telegraph office. The receiver is the ordinary Morse instrument.

The apparatus, which is shown in the accompanying figure, consists of a pulley, A, which, through a chain, B, carries a float. This pulley is about eighteen inches in circumference, and, owing to a counterpoise, is capable of turning from left to right. The terminal, C, is connected with the earth. A pinion, D, fixed upon the axle of the wheel, A, gears with a rack, E, which moves along the rod, FF. This rack carries a small point, G, which presses against the cylinder, H. This latter is covered with an insulating substance, and its surface is provided with metallic projections of great conductivity. These projections have different widths, and, in the rotary motion of the cylinder, the point, G, abuts against them. The duration of the contact depends upon their width. Consequently, the receiver will alternately trace dots and dashes of different lengths, the longest dashes representing meters, the medium ones decimeters, and the dots centimeters. These dimensions relate to the height of the water-level above the critical point. Every time the float rises 2 centimeters, the rack, E, under the action of the



RAVAGLIA'S AUTOMATIC HYDROMETROGRAPH.

pinion, D, goes 2 millimeters to the left, a distance sufficient to indite the dispatch. The variations in the level of the water correspond to the length of the dashes. The scale adopted is based upon the decimal system. Thus 4 dots represent 8 centimeters, and a medium dash 1 decimeter. Then 9 medium dashes and 4 dots represent 98 cm., and a long dash gives the meter. A long dash, 9 medium dashes, and 4 dots would represent, then, 1·98 m. Thus, the following dispatch — — — — — — — — — means that the level of the water is 2·38 m. above the critical point.

The cylinder, H, is set in motion by a system of clockwork that operates under the action of a weight every time the apparatus is thrown into gear. At O there is an electro-magnet whose armature is movable around the axis, Q, and which, on bearing through its extremity against the projection, T, of the cylinder, prevents the latter from turning every time the armature, P, is not attracted by the electro-magnet, O.

At R there is a relay through which the line current passes, and which serves to close the local circuit of the electro, O, thus throwing the apparatus into gear and allowing the cylinder, T, to revolve The current of this circuit is supplied by two Ravaglia-Fabbri elements. The cylinder carries laterally a small projection, T, which, resting against the extremity of the rod of the armature, P, prevents the cylinder from revolving, as we have just said. The extremity of F is supported by a small vertical column.

The apparatus operates as follows: From the pole of the pile in the nearest telegraph office starts the line wire. This passes through the manipulator and Morse receiver, and afterward connects with the hydrometrograph through the terminal, *a*, of the relay, R. When the Morse key is pressed, the current enters through Q, excites the bobbin, I, makes its exit through *b* by traversing Q, runs along the rod of the armature, P, which is in contact with the projection, T, and from thence passes through the cylinder, and is afterward closed through S, C, and the earth. The electro, I, attracts its armature, and consequently the local circuit, *c* O *a*, is closed, so that the electro, O, attracts its armature, P. As soon as the projection, T, ceases to abut against the rod, P, the cylinder is set free, and begins to revolve under the action of the clockwork, M M. The line current is then interrupted at T, and can no longer pass unless it takes another direction.

When the water level does not reach the critical point,

the float being suspended in the air, the entire chain, B, is unwound, and taut. The rack is at the end of its travel to the right, and presses through its extremity against the column that serves to support it. In this position of the parts, the point, G, as soon as the cylinder is in gear, will pass only above that portion of the latter that has no projections and that is covered with an insulating material; so that, the circuit of the line being open, no dispatch can be transmitted. This indicates to the receiving station that the water has not yet exceeded the normal level. If, on the contrary, the water does exceed such limit, then, as soon as one presses the key (which should always be down during the reception of a dispatch), the instrument will be thrown into gear as above stated, and the current, which is interrupted at T, will take the following course: From the positive pole it will pass through the key and the receiver of the telegraph station, and will go to the hydrometrograph, where it will traverse the relay, R, the rack support, and F and G.

As the cylinder, in revolving, successively presents to the point, G, the projections that trace the characters, it results that when once the apparatus is in gear the current will pass through the line wire during intervals of time of varying length, as we have already explained. The receiver, then, will print dispatches that indicate in meters, decimeters, and centimeters the height of the water above the normal level.—*J. Ravaglia, in La Lumiere Electrique.*

NEW ANALOGIES BETWEEN ELECTRIC PHENOMENA AND HYDRODYNAMIC EFFECTS.

By C. Decharme.*

From a theoretical as well as from a practical point of view, the assimilation of the electric current to a liquid one presents an importance that will escape no observer. The reader will understand, then, our

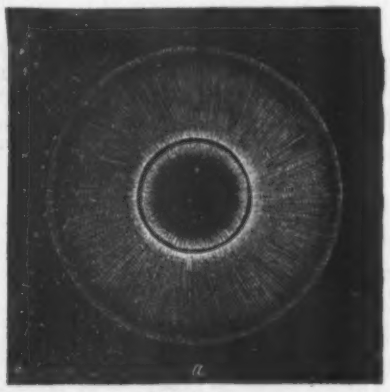


Fig. 1.

anxiety to add some new proofs to those already numerous one that we have hitherto presented in support of such assimilation; for it is through the number of such examples, and their variety and peculiar value, that we hope to demonstrate it perfectly.

Among the best proofs of analogy between the two classes of phenomena compared, we may place the imitation, by hydrodynamic way, of electro-chemical colored rings. We shall, then, upon this subject, present some new examples that seem to us well adapted for bringing into relief the intimate relations that exist between these two phenomena.

ANALOGY BETWEEN ELECTRO-CHEMICAL AND HYDRODYNAMIC RINGS.

I have imitated simple or multiple electro-chemical rings by continuous currents of water directed vertically against a plate of glass. This process, although corresponding better than any other to that of Nobili, for colored rings, does not permit of these latter being fixed upon the plate by means of a heavy powder suspended in water. But if, instead of continuous currents of water, we employ only small liquid columns

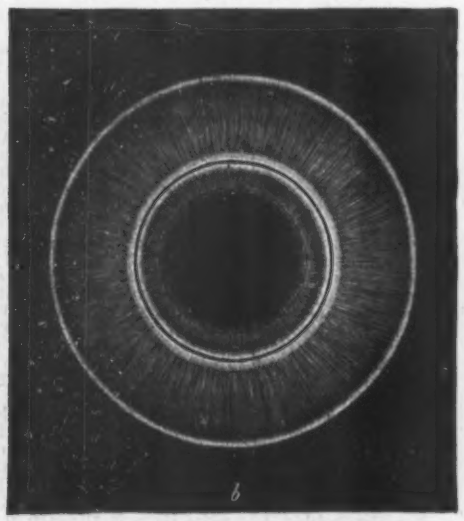


Fig. 2

flowing from a single tube, or simultaneously from equal tubes, upon the ordinary pulverulent deposit (layer of aqueous red lead), we obtain, fixed upon the glass, simple and multiple rings of various systems. Figs. 1, 2, 3, and 4 represent a few varieties of simple rings.

In order to bring about a simultaneous fall of the liquids from all the tubes, conveniently, I use two, three, and four tubed apparatus analogous to those which I employed for continuous currents. I reproduce herewith (Fig. 5) but one of the types of these. Instead of adapting it to the conducting pipe, I plunge it vertically into the water, and then, having closed

Fig. 3.

the upper aperture with the finger, withdraw it gently, and thus have in each tube a column of water whose length may be varied by varying the depth of immer-

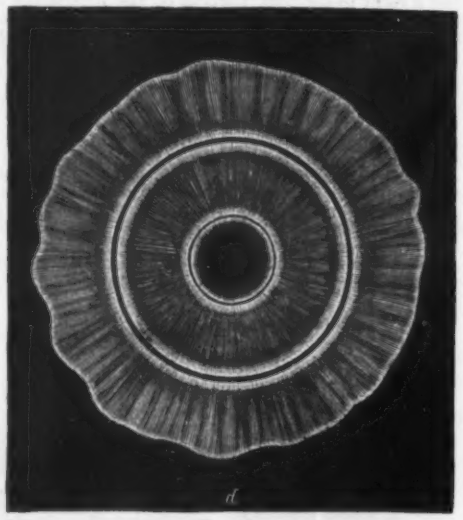


Fig. 4.

Figs. 1-4.—SIMPLE HYDRODYNAMIC RING.

sion. This apparatus is held stationary over the prepared plate, and the finger removed from the aperture. This allows the liquid to flow at the same time from all the tubes, and forms symmetrical rings

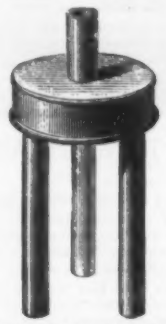


Fig. 5.—DEVICE FOR PRODUCING HYDRODYNAMIC RINGS.

upon the plate. Figs. 6, 7, 8, and 9 represent a few of the rings obtained in this way.

These results caused me to try the more difficult

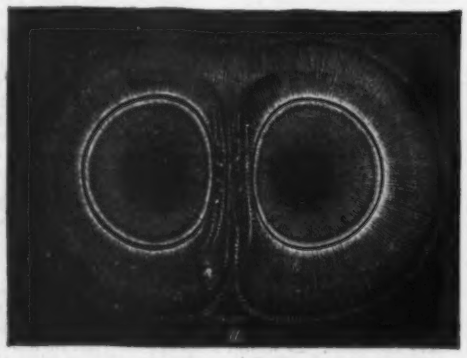


Fig. 6.

imitation of electro-chemical rings—those many-colored rosettes that Nobili obtained in so artistic a way.

IMITATION, BY HYDRODYNAMIC WAY, OF NOBILI'S ELECTRO-CHEMICAL ROSETTES.

As well known, the ingenious physicist employed, for the production of his beautiful metallo-chromic rosettes, a certain number of electrodes of diverse forms that were attached to the same pole and arranged symmetrically above the metallic plate. I first endeavored to imitate the forms and then the color of these rosettes, by hydrodynamic way.

(1.) *Imitation of the Forms.*—To effect this I had

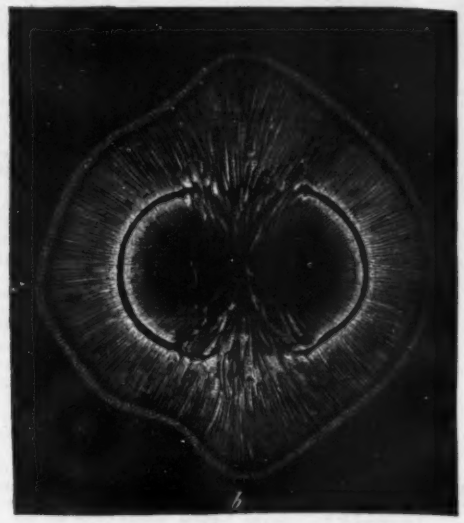


Fig. 7.

Figs. 6 and 7.—HYDRODYNAMIC RINGS (BINARY SYSTEM).

recourse to apparatus analogous to those that I used for producing multiple rings, but more complicated. I shall describe but one of them. This (Fig. 10) is a cylindrical vessel—a sort of drum—whose base carries 9 tubes, 2 inches in length by $\frac{1}{8}$ inch in diameter, eight of which are arranged in a circle and one in the center.

Fig. 8.—HYDRODYNAMIC RINGS (TERNARY SYSTEM).

The top is provided with but one tube, $\frac{3}{4}$ inch long by $\frac{1}{4}$ inch in diameter. This apparatus is used like the simpler ones that have just been described. The nine equal columns of liquid are allowed to fall simultaneously upon the prepared plate, and this produces a

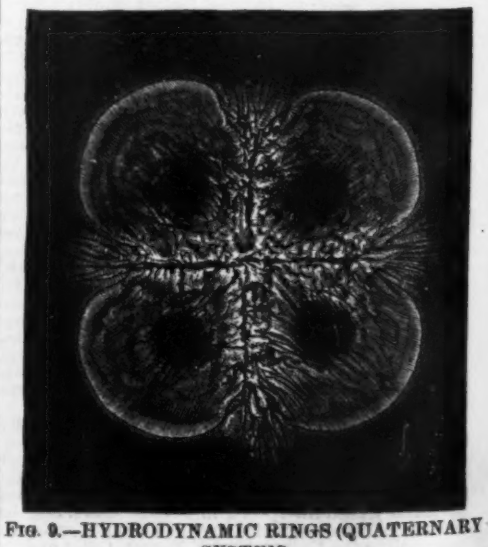


Fig. 9.—HYDRODYNAMIC RINGS (QUATERNARY SYSTEM).

rosette of which Fig. 12 gives a specimen that is quite analogous to Nobili's (Fig. 11). It will be seen that by varying the diameter, arrangement, and number of the tubes, the length of the liquid columns, and the height of fall, we shall obtain very diverse forms of symmetrical rosettes.

With a single tube and a liquid column of greater or less length, we thus produce rosettes of varied forms (Figs. 13 and 14).

The fall of simple drops of water upon the layer of

* In *La Lumiere Electrique.*

red lead gives rise to small and very ornamental rosettes (Figs. 15, 16, and 17).

A continuous current of water applied to the 9 tube apparatus likewise forms liquid rosettes.

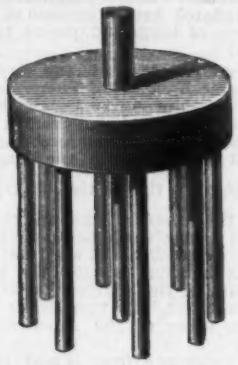


FIG. 10.—DEVICE FOR PRODUCING ROSETTES.

(2.) *Imitation of Colors.*—For imitating the colors that Nobili so skillfully produced in his rosettes, we

FIG. 11.—ONE OF NOBILI'S METALLOCHROMIC ROSETTES.

may employ the following means, which I have applied to the analysis of the respective effects of impinging

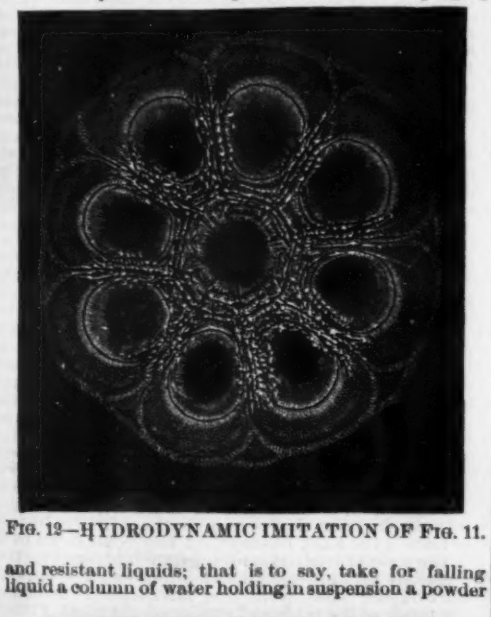


FIG. 12.—HYDRODYNAMIC IMITATION OF FIG. 11.

and resistant liquids; that is to say, take for falling liquid a column of water holding in suspension a powder

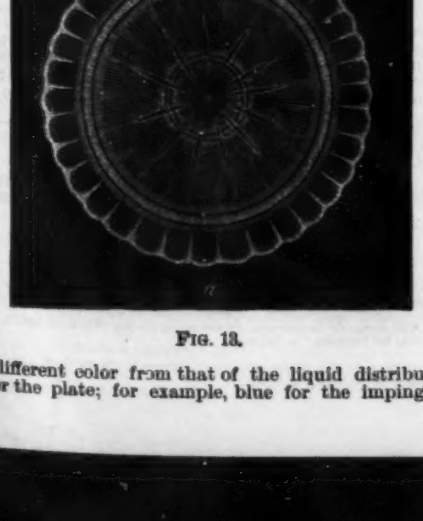


FIG. 13.

of different color from that of the liquid distributed over the plate; for example, blue for the impinging liquid, and water and red lead for the resistant. In this way the effects remain separately inscribed upon the glass plate, where they can be examined and studied at leisure.

FIG. 14.

FIGS. 13 AND 14.—ROSETTES PRODUCED BY A SINGLE TUBE.

The following example will give a preciser notion of this imitation: Upon letting the blue liquid fall from a height of from 2 to 4 inches, we obtain a blue central circle, and then a very narrow red ring. Blue radii cross the following red zone, and the latter terminates in a red edge followed by a blue ring. Beyond, as far as to the periphery, there are portions of red petaloid sectors that form a third ring, which terminates in a narrow, undulating ring of the same color. There are also very slender blue radii to be seen upon these petal-like figures (Figs. 18 and 19).

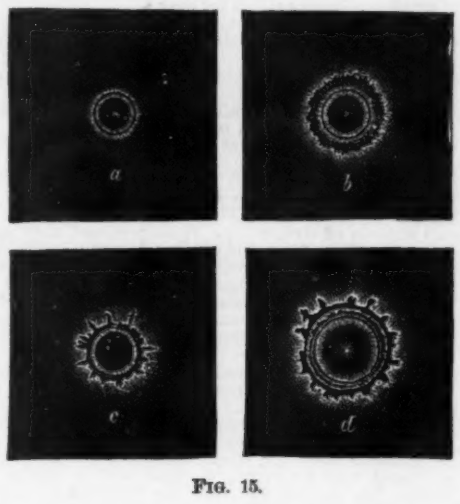


FIG. 15.

Instead of a single impinging liquid, two or three of different colors may be superposed in the same tube. These will not mix to any degree if the tube be narrow and they be successively sucked into it with precaution.

If we apply these processes to the apparatus having nine or more tubes, and, instead of allowing all the liquid columns to fall freely, we blow them out with more or less force, we shall have effects that differ from the preceding, but which likewise give rosettes of more or less complicated form and color.

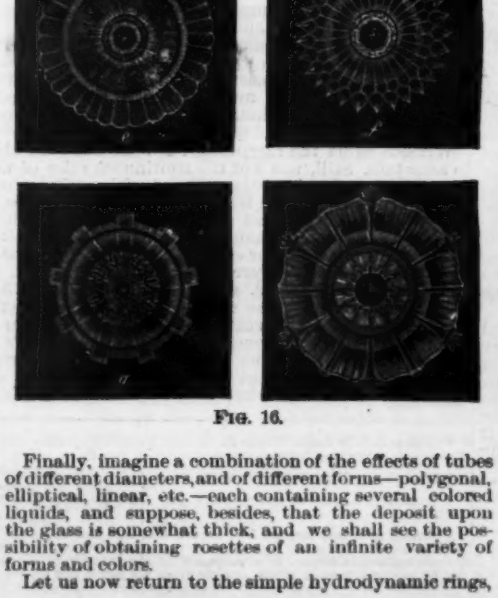


FIG. 16.

Finally, imagine a combination of the effects of tubes of different diameters, and of different forms—polygonal, elliptical, linear, etc.—each containing several colored liquids, and suppose, besides, that the deposit upon the glass is somewhat thick, and we shall see the possibility of obtaining rosettes of an infinite variety of forms and colors.

Let us now return to the simple hydrodynamic rings, whose mode of development, and certain peculiarities as compared with electro-chemical ones, we must explain in order to pursue the analogy up to the details of the phenomena.

FIG. 17.

FIGS. 15, 16, AND 17.—ORNAMENTAL FORMS PRODUCED BY THE FALL OF DROPS OF WATER.

In order to explain the simultaneous formation of the concentric ring and radiating lines in hydraulic rings, we must remark that as the falling column of liquid is cylindrical, it tends to produce a circular impulsion around it. The pulverulent matter forms an obstacle to it, and, through its reaction, constitutes a raised ring that produces a sort of bar which momentarily conquers the force of impulsion; and then the first ring is formed. But the impulsive force is not exhausted, but continues to act and to push ahead the solid and liquid layers that are in its way; and then a second and a third ring are formed.

When the fall is from a sufficient height, the striking body divides in falling, and forms a halo; the rings

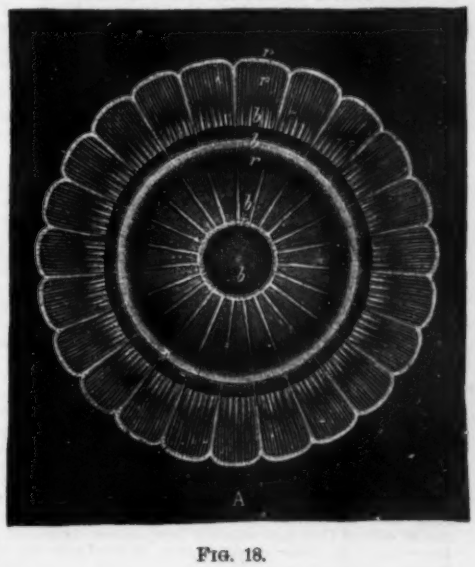


FIG. 18.

break through the preponderating effect of the impulsive force. From this there result radii and sectors of varying width, or drops that, according to the height of the fall, are thrown to a greater or less distance. When such height is not more than three-fourths of an inch or one inch, the impulsive force is feeble, the actions and reactions are more approximate, and the rings are closer together and more numerous, especially when narrow tubes are used. With low falls and long liquid columns, no radiating lines are produced in the rings, because, under such circumstances, the fluid vein does not divide, but falls gently without noise, and spreads out circularly; while with somewhat high falls, that is to say, such as are greater than the distance at

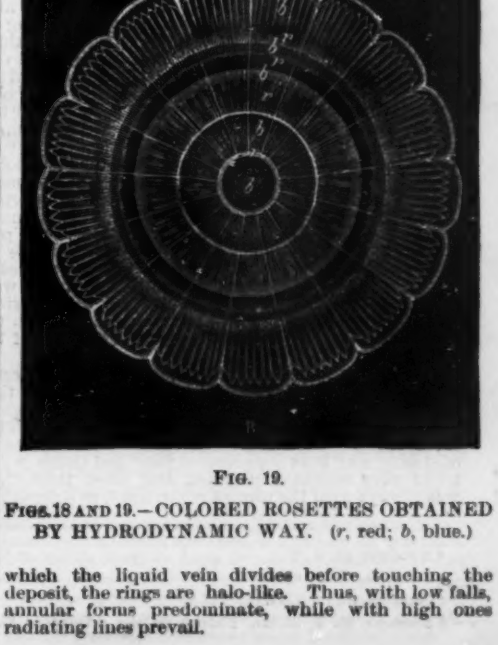


FIG. 19.

FIGS. 18 AND 19.—COLORED ROSETTES OBTAINED BY HYDRODYNAMIC WAY. (*r*, red; *b*, blue.)

which the liquid vein divides before touching the deposit, the rings are halo-like. Thus, with low falls, annular forms predominate, while with high ones radiating lines prevail.

When we compare these effects with those of electro-chemical rings that have no radiating lines, we are obliged to conclude that the force of resistance opposed by the metal to the flow of electricity greatly prevails over the impulsive force of the current. Therefore, in order to come nearer to our hydrodynamic effects, it is necessary to diminish the resistance and increase the tension of the current in a certain measure, since, with too strong currents, we get no rings. We know that for the production of electro-dynamic rings the current must have a certain force, within and beyond which the phenomenon changes character, or rather ceases to manifest itself. Too weak an electric current produces no rings, while too strong a one gives only a black, non-adhesive deposit.

In like manner, in the production of hydrodynamic rings it is necessary that the current shall unite certain conditions of intensity and continuity. Too weak a current does not give marked rings, while too strong a one causes the rings to disappear, and shows nothing but radiating, stellate jets and halo-like layers. This is still another analogy between electro-chemical and hydrodynamic phenomena.

The formation of hydrodynamic rings is more rapid than that of electro-chemical ones. The effect is almost instantaneous. The variable state of the liquid current lasts only the length of time that it takes the water to slide over the plate, that is to say, a fraction of a second; and yet this interval is sufficient for the production of these so extremely delicate figures, these fringes, and their gracefully and symmetrically arranged ornaments. But, rapid as the phenomenon is, it nevertheless consists of successive effects, as may be ascertained by an examination of the ring that usually limits the radiating sectors. It will be found that this is visibly traversed by the latter, and is even somewhat hidden or deformed thereby. Consequently, the jutting forth of the sectors is subsequent to the formation of the ring. We judge here, as in geology, of the relative age of the juttings of matter through the diverse stratifications or layers; those that are traversed being necessarily anterior to those that traverse them. This result shows that it is the impinging liquid that forms the radii, and the pulverulent material that determines the rings. In many cases, according to the nature of the plate and of the solution, the Nobili rings are alternately light and dark, or of two shades. The former effect is due to the metallic surface of the plate laid bare, and the latter to the carriage of matter in solution.

In hydrodynamic rings we thus find two effects—one of them due to the resistance offered by the pulverulent matter spread over the plate, and the other to the impulsive force of the liquid current. The coexistence of these two effects is shown by giving the falling liquid a color different from that of the deposit. If the first color, as well as the second, is opaque, we shall merely have to observe the plate from above and below in order to see this double effect. When the falling liquid is pure water, it leaves after spontaneous evaporation vacant spaces that appear black by reflection, or transparent by transmitted light; and this permits of distinguishing at first sight the two simultaneous effects.

The irregularity of hydrodynamic rings is due to several causes; in the first place, to a want of homogeneousness in the pulverulent layer, the development being prevented or lessened near the larger obstacle, that is to say, near where the layer is thickest; and in the second place to the proximity of the edges of the plate or to the proximity of another ring. In Nobili's rings also we remark causes of arrest in their development, either through want of homogeneousness of the layer of gold, silver, or platinum, or through the plate being insufficiently polished, or through the proximity of another ring or the edges of the plate, or the presence of a few grains of dust, a greasy spot, etc.

The same is the case, moreover, with thermic or chemical rings.

I cite these facts to show that the analogies between the phenomena compared keep up even into details.

A CHAPTER FROM DR. LE PLONGEON'S NEW BOOK, "MONUMENTS OF MAYAX."

Probable cradle of the Egyptian civilization inferred from the titles of the goddess *Mut*, or *Tmau*, the *Lady of the West*, Mut-mati; translated by means of the Maya language.

THE origin of the Egyptians is shrouded in profound mystery. Egyptologists, though they do not accord respecting its birthplace, agree in assigning to it a most remote antiquity; so remote as to well nigh appear fabulous to those who confine their study and knowledge of ancient history to the literal reading of the first chapters of Genesis. Such men are certainly not the most able to criticise the dates offered to us by the monuments, or by the relations contained in the writings of the historians and philosophers of old, whose minds, not trammeled by religious tenets, or the texts of certain books considered sacred, were open to receive the knowledge of the sages they went to consult at Memphis, Thebes, but particularly Heliopolis. The priests of that city were considered the most learned men of their time;* the best to afford information on Egyptian history and chronology, since among other things to them was intrusted the duty of preserving the historical records of the nation. These records seem to have been kept regularly for 11,340 years, at the time when Herodotus lived familiarly with them, and listened to their teachings,† that is, since all communications had been interrupted between the inhabitants of Egypt and those of the "Lands of the West."

What knowledge the Egyptian priests possessed about the beginning and infancy of their people they never revealed, contenting themselves with asserting that they were the most ancient of all men.‡ They seem to have been most reticent on that subject, as also as to why they represented their god Osiris, whose name they seldom mentioned, and when they did it was always with the utmost reverence,§ as a crouching leopard * when in his office as king of the Amenti, that *country of the west*, where the souls of good men were admitted to felicity,† "and where he was said to be seated on his throne, accompanied by Isis and Nike, with the four genii of the Amenti, who stood on a lotus, growing out from the waters, in the center of the divine abode," or why his priests had adopted the skin of the leopard as their ceremonial dress.

Does not this description of the happy dwelling place of the souls of good men, seem to indicate that the motherland of the ancestors of the Egyptians, where they would return after death, as the inhabitants of the celestial empire believe they return to China, was situated in regions where the sun sets in the midst of the water, in a place near the center of those countries?—as Mayax (the empire of the Mayas), for example, particularly if we consider that the hieroglyph used by Egyptian scribes for the names of the *Amenti* and the *west* is identically the same as that which the Maya hierogrammatists, authors of the Troano and Dresden MSS., used to designate this *western continent*, known to-day as America, as I have already shown,‡ and will explain more fully directly.

As far back as history carries us, we find the Egyptian civilization as great as when it disappeared under the yoke of the Romans, but particularly in consequence of the introduction of Christianity in the valley of the Nile. The worshippers of Isis and Osiris were then persecuted by fanatic and tyrannical bishops; the inscriptions and the images of the gods of old were effaced, being covered with a coating of stucco, on which were roughly painted representations of saints, and the temples themselves converted into churches. Later, in the year A.D. 408, the Emperor Constantinus having decreed that the sentences pronounced by Theophilus, patriarch of Alexandria, should be obeyed in temporal matters, and executed without appeal, as well as those of the prefect of the prætorship, this intolerant individual ordered the destruction of all the Egyptian temples. The institutions of Egypt assumed a Christian aspect. The use of the ancient characters was then abandoned. They were replaced by the letters of the Greek alphabet. Only a few among the Egyptians who remained faithful to the old cult practiced them in secret, up to the seventh century of the Christian era, when the ancient mode of writing became extinct for ever.§

Mr. Ernest Renan, not having studied the monuments, civilization, and language of the Mayas, is fully justified when he asserts: "Egypt at the beginning appears mature, old, and entirely without mythical and heroic ages, as if the country never had known youth. Its civilization has no infancy, and its arts no archaic period. The civilization of the old monarchy did not begin with infancy—it was already mature."

Matured! and where? it may be asked, for it is a question not yet solved. Many are the theories of the scholars of our days respecting the cradle of the Egyptian people, and of their knowledge of all the arts and sciences of civilization. Some pretend they came down the Nile from the southern regions in the interior of Africa, disregarding the fact that the Egyptian language has no parentage or affinity with any of the tongues or dialects spoken on that continent, and that the study of their mummies has conclusively shown that they did not belong to any of the negroloid-races.

Others have endeavored to prove that they entered the valley of the Nile from the north, advancing gradually toward the south. This may be, but that does not tell us where the colonists or invaders came from. Others again, and among these are such learned men as Mariette Bey, Dr. Birch, Professor Owen, in fact, all those who follow the German school, and E. De Rouge, his pupils, Sir Gardner Wilkinson, and all authorities on the subject, affirm that they came over the Isthmus of Suez, from the interior of Asia, without mentioning, however, any particular country as their point of departure. Here again we must not lose sight of the fact that the Egyptian language was an isolated one, without relationship with the Semitic tongues, the Sanskrit, or any of the idioms used by Asiatic nations; besides, according to Mr. Champollion le Jeune, the pictures of the Egyptians painted on the walls of the tombs in the valley of Biban-el-Molouk, near Thebes, in a westerly direction, represent them as men with dark-red skins, tall, slender figures, with gentle or regular countenances, clear-cut eyes, straight noses, and open facial angles; differing essentially from the representatives from Asia, with yellow and tawny complexions, aquiline or beaked noses, black beards, sharp and pointed on some, ample and curly on others, with costumes of varied hue and fashion.

The pictures of the Egyptians recall vividly, as to the color of their skin, their plaited hair, their slender figures, their regular features, and white dresses, the representations of the ancient Mayas painted upon the walls of the inner chamber of *Coh's* funereal monument at Chichen-itza.

Whence came the Egyptians? No one has been able to ascertain. Still, are not the continuous cries of the mourners at the funerals, uttered without interruption, "*To the West! To the West!*" a hint that may cause us to look toward the west for the birthplace of their ancestors, as for the mansion of their good men after death? And the *baris*, or consecrated boat of the dead, in which the corpses were carried, *over the water*, to their last resting place, significantly suggestive that this happy mansion was situated in localities beyond the water, as we also surmise from the description of the Amenti quoted above from Plutarch, *De Iside et Osiride*. If the ancestors of the Egyptians came from the East originally, where the sun was supposed to acquire the brilliancy it had lost, why place the abodes of bliss toward the West, that region of darkness, where the sun every day lost the refulgence of its rays, leaving the world in obscurity? Why select the sieve, that utensil used by menials, as symbol of lordship—dominion? Is that also without significance? Is also the serpent with inflated breast, emblem of royalty, worn on the headdress of kings and queens, to be regarded as meaningless?

Herodotus wondered* why the Egyptians styled themselves the most ancient of men; since, as he remarks, no part of the country belonged to them anciently. His surprise would have ceased had they told him that the birthplace of their forefathers was called *Mayax*, a word that meant, in the language of the "*Land of Kui*," that is, the country of the Gods,† the *first land*, the *primitive land*, and that is the reason they called themselves *Rot-en-ne-Rome*, the race of men, the men *par excellence*, a word having the same signification as the name *Caraïb* of the inhabitants of the Antilles and of the southern continents of the "Lands of the West," the vocable *car* or *cara* being synonymous in many of the American and Asiatic languages; having in all the meaning of man *par excellence*, of "warrior" (from it may have come the word *Karl* of the Germanic tongues and our English "war" and "warrior").

It seems natural that the colonists who settled in the valley of the Nile, when they came from fatherland, should have brought with them the arts and sciences known in the country of their birth, with all the refinements of the civilization there existing, but somewhat impaired, however, as it happens in our days in all new colonies. Among the arts foremost were architecture, sculpture, painting, and writing. This would, of course, account for the remarkable similarity of the ancient monuments, and of the hieratic alphabet of the Egyptians and that of the Mayas, as we have found it from the inscriptions carved on the facades and walls of the temples of the Gods, on those of the mausolei of their great personages, on those of the palaces of their kings. No doubt that the colonists brought also the traditions of their people, the religion of their fathers, consequently the cult of the heroes deified and worshiped in the old country, whose history Hermes wrote in hieroglyphs, in the language of the gods, in ten volumes, which related to the things of the said gods, and the religion, according to Clemens of Alexandria.‡

That the names of certain localities in the motherland were preserved in the legends reciting the titles of the gods and goddesses, we have already seen, when explaining those of Osiris as king of the Amenti;§ and as I will endeavor to show by analyzing the legend that accompanies the representation of the goddess *Mut* or *T-mau*, worshiped at the city of Bubastis, and who was also called the *Lady of the West*.

Mr. Champollion le Jeune and his disciples have looked in vain toward the south for the site of the cradle of the Egyptian civilization. With no better success others have pointed toward the north. Savants who are considered as great authorities in all matters pertaining to Egyptian history have asserted that the first civilized settlers, known to history, who established themselves on the banks of the Nile came from the East, but they failed to designate the exact eastern locality wherefrom they started. To the learned Abbe Brasseur de Bourbourg belongs the honor of having been the first, in his conference at the Sorbonne, in Paris, May 2, 1864, to call the attention of the savants to the identity of the traditions—cosmogonical, religious, and historical—of the people of America and those of Asia and Africa. He was indeed the first to point out the "Lands of the West" as the probable cradle of Egyptian civilization. "So," says he, "wherever we cast our eyes on the antique cosmogonies, be it in Africa, Asia, or America, on all sides we find not only analogies, but so great similarity that it would be inconsequent to see in them mere coincidences, effects of hazard only."‖ And again: "It could only be a remembrance of their antique filiation that caused the Egyptians to point toward the Occident as the birthplace of their ancestors, as the *Amenti*, where the souls of their dead went to rejoin their forefathers."¶

Well might an unprejudiced thinking mind, after perusing the introduction to the work of Bishop Landa, "Las Cosas de Yucatan," in which, with so great erudition, the savant Abbe points out the identity of the mythologies, of the traditions of all kind, of the linguistics, even, of the nations dwelling in America and those inhabiting Africa and Asia, wonder why the scientific men of Europe have so persistently refused to recognize the truth proclaimed by Abbe Brasseur. Why, closing their ears to his revelations, their eyes to the light that, emanating from the West, cast its rays into the darkness that surrounds the primitive history of man in the East, history that has come down to us in the form of tradition shrouded in fables and myths, creations of untutored imaginations—why, even with the evidence before them, they have dared to denounce the result of the profound studies of the great French archæologist as vagaries of an enthusiast—had not the Abbe himself fearlessly indicated the cause. "Belonging," says he, "to no coterie, scientific, political, or religious, we have always walked with entire independence, and will continue to do so, in the path of science. We seek for truth, we will seize it wherever we find it. . . . In a near future the importance of our researches will have to be acknowledged."** So he wrote twenty years ago. Since then the learned and fearless spirit has shaken off his mortal coil. But if he still lives and feels—if it be any satisfaction to him, then let him know that at least one of his co-workers in the same

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* Herodotus, lib. ii., lii.

† Herodotus, lib. ii., cxliii.

‡ Herodotus, lib. ii., ii.-xv.

§ Herodotus, lib. ii., liii-lxv. Plutarch, De Iside et Osiride, s. 21.

* Champollion le Jeune, Precis du Systeme hieroglyphique des anciens Egyptiens. Planches, Noms divins symboliques, No. 92.

† Plutarch, De Iside et Osiride, s. 79.

‡ SCIENTIFIC AMERICAN SUPPLEMENT, page 6468, No. 405, October 6, 1883.

§ Strange as it may appear, it is toward that time that the use of the ancient hieratic characters, in which the mural inscriptions are written, became extinct in Mayax, in consequence of the invasion of the country by barbaric Nahuatl tribes, coming from the south and southwest

* Herodotus, lib. ii., xv.

† SCIENTIFIC AMERICAN SUPPLEMENT, No. 405, p. 6468, October 6, 1883.

‡ Clemens of Alexandria, Strom., lib. vi., p. 196.

§ SCIENTIFIC AMERICAN SUPPLEMENT, October 6, 1883, p. 6468, No. 405.

‖ Brasseur de Bourbourg, Introduction to the Work of Landa, "Las Cosas de Yucatan," lxxviii.

¶ Brasseur de Bourbourg, Introduction to the Work of Landa, "Las Cosas de Yucatan," p. lxxxv.

** Brasseur de Bourbourg, avant propos to the work of Landa, "Las Cosas de Yucatan," p. ii.

field of inquiry, though he does not always agree with him in his conclusions, at least fully appreciates his work, his knowledge, his discoveries, the truth concerning the cradle of Egyptian civilization he was the first to make known to the world.

Although Abbe Brasseur and myself have followed two distinct roads in pursuing our researches, we have reached identical conclusions. He studied the ancient traditions still lingering among the native populations of the different countries of Central America, consulted their sacred books, learned their languages, and with the data thus collected tried to reconstruct the past history of the race, trace its origin, that of its traditions, and the locality of its birthplace. As he obtained a more perfect knowledge of the subject, the light began to dawn from the facts before him, then he became more and more impressed with the identity of the traditions and myths of the people of Central America, and those of the inhabitants of the countries on the opposite side of the ocean, the origin of which is for them, and has been in all times, wrapped in mystery; while in America, all things, from the beginning, have their explanations, their *rationale*.

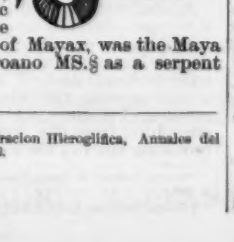
I have followed a different course of inquiries. I have confined my studies to the ruined palaces and temples of the Mayas, disregarding for the time being the traditions of the natives, the relations of the chroniclers of the time of the conquest, the opinions of the historians who passed for the most versed on the ancient history of the country, lest their ideas should remain impressed on my memory, and hamper the freedom of my own mind; thus preventing me from understanding the mute but eloquent language of the ruins. I resolved to receive directly my knowledge from the ancient personages whose portraits are sculptured on the walls and columns of their public buildings. I have asked them to recount to me their own history; that of the builders of these grand monuments that Time even, that destroyer of all things, has respected; that of their own nation. I have endeavored to solve the enigma of the relations contained in the inscriptions carved on the facades of the temples and of the palaces; to understand the meaning of the events and customs portrayed in the mural paintings that adorned the walls of their penetralia. For me also, by little and little, the light has dawned from chaos, and I also have comprehended that all the primitive traditions of mankind, from the myth of creation, have had their origin in Mayax, and that in the country of the Mayax—*Kuiland*—must be sought the starting point of that high civilization that, in remote times, has radiated over the whole earth; and that Egypt, as Chaldea, as Japan, has received its knowledge in all the arts and sciences, as also its gods from the "Lands of the West," as I will proceed to show by interpreting, by means of the Maya language, the legend attached to the image of the goddess MUT or T-MAU.

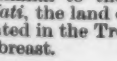
Before entering into this explanation, I must not fail to mention the interesting and erudite work published in these later years, by Mr. Ignatius Donnelly, "Atlantis, the Antediluvian World," in which the author exerts himself to prove that the primitive traditions of mankind, and our civilization, emanated from the great island that the priests of Sais and Heliopolis told Solon had been destroyed by disappearing under the waves of the Atlantic ocean, nine thousand years before his visit to Egypt. That island, they said to the Athenian legislator, was called *Atlan*. ATLAN! This is a Nahuatl word, composed of the two primitives *atl*, water, and *tlan*, near, under, in between. Its meaning is a place near, under, in or between water,* a name that can be applied to many localities according to their position respecting water. But now comes the query: How did the Egyptians come to be acquainted with that Nahuatl word, unless they had intercourse with the people who spoke the language to which it belongs? How should we know the names of cities and localities, say in Siam or Burmah, if we had no communications with the inhabitants of those countries?

While agreeing with Mr. Donnelly on many points, I certainly differ from his conclusions on many others; as, for example, when he asserts that the civilization radiated over the earth solely from that Altantean lost island. I think that all the *facts* tend to show that it emanated from these "Lands of the West," in which we live, in which we move, in which we have our being, lands which in reality seem to have been the birthplace of the primitive traditions of man, the mother country of all the gods and goddesses of old, but certainly that of the goddess MUT or T-MAU.

She was the second member of the Theban triad. Her hieroglyph consisted of a vulture and of the letter *ti*, the Egyptian feminine article. Some writers are of the opinion that she represented nature, fertile and fruitful, hence her emblem, a vulture, symbol of fecundity, and phonetic character for *mother*. She was therefore called the Mother emphatically, for, as Horapollo observes: "Whenever the Egyptians wish to designate a mother, they represent this bird."†

One of her titles was said to be the "Lady of the West;" as such her attributes are unknown. Many are disposed to identify her with the winged serpent called *uati* by the Egyptologists, the Buto of the Greeks, whose oracle was the most celebrated in the world, since Herodotus tells us that the people had greater veneration for it than for that of any other deity.‡ According to Sir Gardner Wilkinson, *uati* was styled the LAND OF THE WEST. He gives for her emblem as such the annexed figure,



the legend of which  is read by the Egyptologists UATI, though it should in fact read *mati*, according to the Maya rendering, the sign being equivalent to our letter M, initial of the word *motz*, generic name for root, similar to the English *moss*. *Mati*, the land of Mayax, was the Maya Empire, represented in the Troano MS.§ as a serpent with an inflated breast.

*Orozco y Barra, Ensayo de Descifracion Hieroglifica, Annales del Museo Nacional de Mexico, vol. i., p. 242.

†Horapollo, Hist., lib. i., cap. ii.

‡Herodotus, lib. ii., LXXIII.

§Troano MS., part ii., plate xvii.

The "Lady of the West" was also represented as in the adjoining plate, and the legend accompanying it reads, when rendered by means of the Maya language: "She of the lands of the west. Lady of the country of *Mati* (Mayax) in the west. Lady of that which covers all (heaven), the harvester of the corn of the gods, Mut, the Lady of Mayax, the cultivated land."

Let us decipher the legend by analyzing each of its component parts. Examining it, we cannot fail to notice that it begins with the sign , which is equivalent to our letter S or X. It is the simple pronoun of the third person, in the feminine gender. Singular corresponding to the Maya feminine article *ix*, written by elision *x*, initial letter of the verb *xachcun* of the fourth conjugation, the meaning of which is to part, to divide, to separate,* as figured by the sign, a line divided by two other smaller cutting it at right angles.

The next character *ti*, has various meanings in Maya. *Ti* is either an adverb of place; in that case it stands for *place, there;* or it is a preposition, indicating the dative case, as *to, for.*† We have already said that in Egyptian it is the determinative article feminine singular, our English *she*.

Then comes , a very peculiar symbol, that has been interpreted by modern Egyptologists *mountainous* country simply. Still it is a component part, as I have already said, of the hieroglyph for *the West, the Amenti*, and is most remarkable, since it also enters into the composition of the character by which the authors of the Troano and Dresden MSS. designated the *Lands of the West*, surrounded by or near the water, the *Atlan* of the *Nahuatl*, from which the *Atlantic* Ocean derives its name.

If we analyze the character used by the Maya hierogrammatists, we find it composed of , a figure representing the contours of the eastern shores of the American continent from Newfoundland on the north to Cape St. Roque in Brazil, on the south; of the sign for place, and of symbol of the three great continents that formed the *Lands of the West*, North and South America, and the land of the Scorpion (Zinau), the Antilles of our days, remnants of the great land, said by the author of the Troano MS., at the beginning of the second part of his book, to have been submerged under the waves of the ocean during a series of fearful cataclysms.‡

America, according to this Maya author, would then have formed the principal part of that country in the midst of the water, *Atlan*, where Kronos was said to reign supreme. The trident placed by the Greek mythologists in the hands of their God of the Sea, Poseidon, as scepter, would then be, as the sign of the Maya and Egyptian hieroglyphists, symbolical of the three great continents surrounded by water, forming the "Lands of the West." The sentence can therefore be interpreted, "*She of the West.*"

The second part of the legend is still more significant as it clearly indicates over what country in the *Lands of the West* the goddess held sway.

Effectively, the first sign to be noticed in that hieroglyph is the feather, , called in the Maya tongue *kukum—kukumtok*, that is, literally, *feather and flint*, or the feather held with a jewel, was the name of the plume worn by the kings, the high priests, the warriors, by all personages of rank. Those who, after their death, were deified continued to be represented in the bass-reliefs, in the paintings, or by the statues raised in their honor and to their memory, with all the badges of their former exalted position. May not this account for the feather being regarded by the Egyptians as emblem of divinity? All the Egyptologists—Champollion le Jeune, Rouge, Brugsch, etc.—all agree in taking the feather as phonetic sign for God. Herodotus tells us that when the priests of Egypt showed him the statues of their kings and high priests which they have preserved for three hundred and forty-one generations, they assured him that before these men governed the country, the gods had reigned over the Egyptians, living among them, one always occupying the throne, the last being ORUS, *the son of Osiris.*§ *Ku*, radical of the word *kukum*, means in the Maya language GOD—emphatically, the divine essence. *Ka* in the Egyptian was the word for spirit—genius. In the case under consideration the sign would mean goddess. Under it we see the sign, *ti*, which we have said is in Maya, as well as an adverb of place, a preposition indicating the dative case, corresponding to our English *to* or *for*. It surmounts the Maya and Egyptian letter *md*. According to Champollion le Jeune, *ma* in the Egyptian language means site, country. "The word ΤΟΠΟΣ," says the learned Egyptologist, "of the Greek text of the Rosetta inscription is expressed in the hieroglyphic part of the tablet by an owl for M and the extended arm for A, which gives the Coptic word *Ma* (*md*), site, place, earth."‖

We see in the Troano MS. that the Maya scribes represented the earth under the figure of an old man,¶ the grandfather, the ancestor, MAM, which by elision gives *ma*, the earth; MA, radical of our word *mama*, which is but a reduplication of *ma*, and has the meaning of *mother* in many languages—the mother earth.

No one has ever explained why the learned priests of Egypt gave to the sign the value of *ma*. May not this failure to account for the origin of said character be ascribed to the want of knowledge as to who were the inventors of the Egyptian alphabet, resulting from the utter ignorance in which we are as to the birthplace of their civilization? They themselves ignored, or pretended to ignore, who invented the alphabet they used. "The Egyptians," says Champollion, "who, no doubt, had forgotten, or had never known, the name of the inventor of their phonetic signs, at the time of Plato, honored with it one of their gods of the second order—THOTH—who likewise was held as the father of all sciences and arts."*

It is evident that we can learn nothing from the Egyptians of the motives that prompted the inventor of their alphabetical characters to select this peculiar figure to represent the letter M, *md*; we must therefore seek our knowledge from a different source.

The Mayas, we are informed by Bishop Landa,† and the monuments sustain his assertion,‡ made use of the identical sign, and ascribed to it the very same meaning. We may perhaps find out from the study of their books and inscriptions the reason that induced their wise men, when forming the letters of their own alphabet, to select this peculiar and strange geometrical figure for M, radical of the word *ma*, the earth, itself radical of MAYAX, the name of the country where they dwelt and from which their people derived their own name.

Who knows but that the same cause which prompted them to adopt it did not suggest it also to the mind of the Egyptian hierogrammatists, if it be argued that these did not receive their knowledge of the art of writing from the Maya learned priests?

In the origin of language, names were given to objects and animals according to some peculiar inherent characteristics possessed by them, such as shape, voice, customs, etc.: to countries in accordance with their climate, geological formation, geographical configuration, natural productions, or any other remarkable accident. This rule seems to find its confirmation in the symbol of the Mayas.

Effectively, if we draw round the Yucatecan peninsula a geometrical figure, following with straight lines the direction of its eastern, northern, and western coasts, it is easy to see that the resulting drawing thus obtained will unavoidably be the sign , equivalent to of the Egyptian alphabet for *ma*, the land, the earth, the country *par excellence;* MAYAX, the land of the Mayas, the Yucatecan peninsula of our maps.

The hieroglyph then reads, *Goddess for Mayax.*

We know that represents the West; the whole sentence may be translated, *Goddess of Mayax in the West.*

The next phrase is , another remarkable hieroglyph, that has been translated by the Egyptologists *Lady of Heaven*. It is composed of the *sieve* or *tammy* , of the preposition *for* or *to*, and of the *cover* that has been rendered *heaven*.

The sieve or tammy was among the Egyptians the ideographic character for power, dominion, sovereignty, lordship.

It may appear strange to us, who know so little of the motives that prompted the wise hierogrammatists of Egypt to adopt such or such peculiar sign to represent certain objects or ideas, to conceive why they have chosen the *sieve*, a utensil only used by their slaves and menials, and which should naturally have been the emblem of servitude and slavery, as symbol of dominion, mastership, power, lordship. At first sight this seems a contradiction, a strange antithesis, difficult to understand and still more so to explain, unless we take it for granted that they desired by such selection to perpetuate the memory of some important event that had occurred in the life of their people.

In all times, in all countries, the mind of man is the same; customs and manners only change. In order to comprehend certain facts that we find in perusing the history of the nations that have preceded us, we must judge of them by analogy.

As to-day, for example, colonists starting from their mother country give to the new places where they establish themselves names commemorative of those where they dwelt in their old home, and which recall to their minds memories of their early years, may it not be probable that the same thing has taken place of old? In fact, history tells us it has taken place. Then the colonists who came and established themselves on the banks of the Nile may have preserved in the names of the new places they founded, in the symbol of these names, that of the country of their birth. These symbols, well understood, may in turn serve us as guides to find that birthplace of theirs. May it not seem very natural that these colonists should have said: "We people of Mayab have conquered this valley, of which we are now the lords and masters; in order to keep among our descendants a knowledge of the country of our birth, let us adopt as emblem of dominion, of power, of lordship, the sieve, name of our mother country, MAYAB." *Mayab* was anciently the name of the Yucatecan peninsula. In the Maya language *Mayab* means a *sieve*, a tammy, a name that was probably given to the country by its inhabitants on account of the great absorbent quality of its stony soil, which, in an incredibly short time, absorbs the water at the surface. This, percolating through the pores of the stone, as through a *sieve*, is afterward found filtered, clear and cool, in the caves and senotes, where it forms vast deposits.

If indeed this is the reason why the Egyptian hierogrammatists adopted the *sieve* as emblem of dominion and lordship, then we have found the country in the

*Beltran, Arte y Vocabulario de la Lengua Maya; Pio Perez, Maya Dictionary.

†Troano MS., part ii., plates ii., iii., iv., v.

‡Troano MS., part ii., plates ii., iii., iv., v.

§Herodotus, lib. ii.

‖Champollion le Jeune, Precis du Systeme Hieroglyphique, etc., text, p. 125.

¶Troano MS., part ii., plate ii.

*Champollion le Jeune, Precis du Systeme Hieroglyphique, p. 355.

†Bishop Landa, Las Cosas de Yucatan, Maya Alphabet, ch. xii., p. 239.

‡SCIENTIFIC AMERICAN SUPPLEMENT, No. 466, p. 6468, Oct. 6, 1883.

west wherefrom came their ancestors; we have found the place where the Egyptian civilization had its infancy and its growth—the place wherefrom it was imported in the valley of the Nile, on the banks of the Euphrates, and in many other parts of the earth.

At all events, , the sieve in the case under consideration, stands for lady; then comes *ti=for*, and the sign , which is a cover, and has been interpreted *heaven*. If, however, we take into consideration the general purport of the whole legend, and that the author had in his mind the recital of the titles and characteristics of an individual in direct relation with a certain country, it will be necessary to select among the various Maya words that may convey the idea of a thing being covered, or of the covering itself. *Muy*, an adjective, meaning covered, hidden, may be the most appropriate—since the goddess *Mut* or *T-mau* seems to have been regarded as the harvester of the crops of corn for the gods, and that the primitive *Muy* is the radical of *Muyal*. *Muyal* as a noun means cloud; as a verb, to be covered with clouds, to be cloudy.

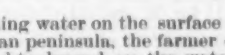
There being no running water on the surface of the ground in the Yucatecan peninsula, the farmer of old, as that of our days, had to depend on the water from the clouds for the irrigation of his fields. The rain is, therefore, the *sine qua non* for the production of good crops. But as the sky is seldom, if ever, clouded during the dry season, the goddess, or mistress, of harvest may have been considered as lady of the clouds that in the wet season overcast the whole sky, and by their shadow protected the fields from the scorching rays of tropical sun. I think that we may interpret the sign *Muyal*, the clouds that cover the whole earth. The hieroglyph may, then, be rendered "Lady of the Clouds;" by extension, "*Lady of Heaven.*"

As to the last sentence of the legend, , it has been interpreted "Regent of the gods." The Maya language in this instance differs from this accepted meaning of the hieroglyph. Without entering into consideration of the motives that have prompted the Egyptologists to translate the sign vase, corresponding to our letter AA, *regent*, I will only observe that the Maya word for *a vase in general*, without designating which, is HOOCH. But HOCH as a noun is also the *harvest of corn;* and as a verb, *to gather the harvest of corn.* I shall therefore render the sign *harvester of the crops of corn.* Then follows the preposition *ti =of*, and the three small banners, , the meaning of which in Mayax, as in Egypt, is GODS.

Pan is the Maya for banner, standard. A banner, it is well known, was always carried before the king or chief. In the battle it indicated the place where the chief or leader stood. The banner was also called *lacam*, being the ensign round which the warriors rallied. This word brings to mind the λαγετης of the Greeks, *the leader of people*. *Pan* in the Nahuatl tongue has a like meaning, for it is that which is elevated, that which is above. The kings, the chiefs, the illustrious warriors, particularly those who fell on the battlefield, were often granted the honors of apotheosis. The banner became symbolical of defied hero, hence of a god.

Pan among the Greeks was an Arcadian rural god, the worship of which was introduced in Athens after the battle of Marathon. Hermes was said to be his son, Maia being his mother.* *Pan*, we are informed by Herodotus, was considered by the inhabitants of the nome Mendes as one of the eight gods; they said it was one of the oldest of the twelve.† Its worship was of very ancient date among the Egyptians.‡

Speaking of the god Pan and its worship in America, Brasseur de Bourbourg says, on the authority of Sahagun, of the anonymous conqueror, collection Ramusio, and of the Codex Mexicanus: "We find in America, as in Egypt and in Greece, *Pan* and *Maia*, with the same names, with the same attributes, with the same variety of personifications and symbols. *Pan-tecatl* in the Mexican ritual is the man *par excellence*, the god of lewdness and inebriety. It is he who under the name of *Cuextecatl*, crazed with drunkenness, roams through the country, exposing his nudity. His consort is *Maia*, who invented the art of wine-making."§ This god was worshiped throughout Mexico and Central America. The Nahuatls introduced his worship in Mayax at the time they invaded the country at the beginning of the Christian era. His symbols are to be found in many places in the northern parts of the peninsula, and at Uxmal particularly statues, *habentes veretrum erectum*, are still seen on the north side of the north facade of the palace of King Can. This building is generally known under the name of *Monjas*.

The whole legend  would then read in the Maya language, *ix ti chikin x-ku ti Mayax ti chikin, colel tí muyalob-hoch ti Kuob;* that is: She of the West—Goddess of Mayax in the West—Lady of the clouds—harvester of the crops of corn of the gods.

If we now turn our attention to the legend over the head of the figure of the goddess *Mut* or MAU, we will find it is no less significant.

Effectively, standing over the sign *ti* of the title of the goddess , that I have interpreted *Goddess of Mayax*, we see a bird that is not a vulture, though we are told that her name signifies *mother*. The bird is a hawk, the same placed over the head of *Nat* or *Neith*, as Goddess of the "West."‖

In Egypt, the *macaw* (Ara militaris), MOO in the Maya language, was unknown. It was the totem of Queen Moo, of Chichen itza, wife and sister of *Coh* or *Chaacmol*, daughter of King Can, who, deified after her death, became the goddess KINICH-KAKMOO—*the fiery macaw with eyes like the sun*—whose temple was on the summit of the high mound on the north side of the square in the city of Izamal.

As the emblem of the goddess *Mau*, the Egyptian adopted the hawk, a bird that approaches most to the macaw in size and fierceness, if not in color. It may therefore be regarded as the name of the goddess *Mau = Moo*. I do not translate it *Mut*, because this word is the name in Maya of a very distinct kind of bird—it is the pheasant; and the Mayas had a god which they called *Ah-Mut*, the master or lord of the pheasant, being one of the names of Itzamna, the culture hero of the Mayas.

Totem of princess Moo, queen of Chichen, adorning the mausoleum of Coh, her brother and husband.

As to the symbol the Egyptologists have translated it *cultivated land*. It corresponds to this of the Maya hierogrammatist, author of the Troano MS., *ti*, the dry land, the plains out of the water proper for cultivation. The legend would, then, give us

MAU or *Moo, goddess of Mayax, the cultivated land.*

In Izamal, as in the city of Buto, the most celebrated oracle of the country of Mayax existed at the temple of *Hinich-Kakmoo* in the city of Izamal; which was the sacred city of the Mayas, residence of the high priests. Of this oracle Father Lizana* says: "So also there was another temple or mound on the northern side of the square, and to this day the highest. It was called *Hinich-Kakmoo*, because on its summit there was a temple, and in it an idol of that name; the meaning of it in our tongue is '*Macaw of fire with eyes like the sun*,' the same which alighted from on high, as does the macaw, with plumage of various colors, flying at midday, and set fire to the sacrifice. And this god was highly venerated; and they said that when mortality, pestilence, and other evils occurred, everybody, men and women, repaired to it, carrying numerous gifts and offe ings, which they offered, and that in the presence of the assembled multitude, at midday, descended a fire (as I have said) which consumed this sacrifice. And the priests told them what was to happen, and all what they wanted to know concerning the epidemic, the famine, or mortality. And according to that, they remained well informed of all that was to take place, either good or evil, notwithstanding that oftentimes everything happened contrary to what they were told." The historian Father Cogolludo relates the same facts.†

Mut, or *Mau*, was also represented with the head of a lion or cat,‡ and the cat was peculiarly sacred to her§ in that case. On her head she bears a disk, from which rises the uræus, or royal asp, and in her hand she holds the usual scepter of the Egyptian goddesses.

It must not be forgotten that Isis, as queen of the *Amenti*, that is, of the *lands of the West*, has for symbol a crouching leopard, to which the O, egg, and the feminine article were added to determine the gender. Would not that tend to show that *Mau* or *Mut* was but a representation of the goddess Isis herself in her attributes as Lady of the West, of the Amenti? In that form Mut was connected with Bast, worshiped with great pomp in the city of Bubastis, where Herodotus asserts she had a magnificent temple, where, at a certain time in the year, people flocked from all parts of the country, to assist in the festivals held in her honor, and listen to her oracles, just as the people of Mayax used to go to the temple of *Moo* at Izamal, and listen to the oracles.

I will not finish these remarks without calling the attention of the reader to the fact that the principal form of negation, according to Bunsen, was in Egypt translated *nen*,‖ and that Bishop Landa asserts that the principal form of negation among the Mayas was *ma*.¶ It is easy to perceive that both signs are identical. Is this a mere coincidence to be ascribed to hazard?

We find in the Troano MS. that the sign forms part of the name MAYAX, being in fact its radical syllable.** It is clear, of course, that among the Mayas said character owes its origin to the peculiar geographical configuration of the peninsula (Yucatan), and its position between the Gulf of Mexico and that of Honduras, which is part of the Caribbean Sea, these two inland seas being represented by the sign *imix*, bosom, deep place. But the Egyptologists have never explained why the Egyptians adopted this character for sign of their negation, and called it *nen*. Again, NEN in Maya signifies mirror; and anciently, according to the author of the Troano MS., the Gulf of Mexico was called NEN-HA, the mirror of water.

I will add that *ma* among the Mayas, as in Greece, was a particle used in strong protestation and oaths, either affirmative or negative, according to the context. Pedro Beltran de Santa Rosa, in his grammar and *vocabulary* of the Maya tongue, says:* "*Ma* changes the active verb in *ic*. If placed before the verb, it is negative—*ma uohel*, I do not know. If postponed, it is affirmative—*uohel ma*, yes, I do know."

The same rule applies to the particle *μα* in Greek—*ναὶ μὰ τόδε σκῆπτρον*, yea by his scepter; *οὐ μὰ γὰο Ἀπόλλωνα*, nay by Apollo.†

Are all these identical facts mere coincidences? It is for you readers to decide.

AUGUSTUS LE PLONGEON, M.D.

OCEAN AND AIR CURRENTS.

UNDER this title Mr. Thomas D. Smellie has issued a little pamphlet, in which he argues that the cause of both ocean and air currents is to be found in the rotation of the earth. He begins his investigations with a simple experiment, which he describes as follows:

"If you take a flat-bottomed circular vessel, formed to revolve horizontally, partially fill it with water, and make it revolve gently, you will find the vessel at first slip from under the water, so as to give the water relatively a backward motion. A similar result will follow though you try different speeds within the limit of the water being free to take its own motion—the greater the speed, the greater the backward motion. After a few revolutions the water will begin to acquire some of the forward motion of the vessel; this will decrease the backward motion, and if continued long enough to allow the water to acquire as much of the vessel's motion as it will acquire, it will take almost, but not quite, the same motion, for the water toward the surface will still lag behind the vessel."

This, according to Mr. Smellie, illustrates precisely what occurs on the earth's surface, and forms the basis of his theory of currents. The earth's rotation being toward the east, the lagging of the ocean at its surface would cause a westward current until obstructed by continental masses, and this current would naturally be greatest where the earth's motion is greatest, that is, at the equator; while its volume would be limited by the amount which could return to its source by other routes. Observations bearing on the question of currents are adduced in support of the main argument, and while they are all doubtless potential factors in explaining the circulation of the air and water, we must take issue with Mr. Smellie and his supporters on several grounds.

Distinct from this theory of rotation, two agents have been cited by different investigators as capable of producing and maintaining this constant circulation of water and atmosphere. These are the forces of wind and heat. It has been held by a large number of naturalists that the atmospheric movements were caused by this same process of lagging behind which is now brought forward to account for ocean currents as well; and that, acting upon the waters in the open ocean, these powerful and constant winds produced accompanying currents in the water. Thus in the last analysis it will be seen that both theories depend primarily upon the earth's rotation, and differ only in interposing an intermediate mechanism for impressing this movement upon the water. Of the two, Mr. Smellie's statement of the case is much the more rational, and deserves careful attention, but this it has already received, for it is by no means a new theory, and with slight modifications is even encyclopædic. American naturalists have investigated the influence of the earth's rotation, and in accounting for the causes of ocean currents have given it due consideration, but they have also kept in mind other causes equally important. The difference between the temperature of a polar and a tropical sea produces such marked discrepancies in the specific gravity of their waters that it is quite impossible to ignore the large influence which such thermal extremes must exercise upon circulation. So delicate are the balances of nature, that every winter season shows us large bodies of water moving in obedience to thermal changes of no more than three or four degrees. It is well known that water possesses its maximum specific gravity at a temperature of 4° C., and that consequently up to this point it sinks to the bottom of its receptacle. But its behavior in passing through the four degrees which still separate it from the freezing point shows its constant sensitiveness to even such slight changes, for as the temperature sinks the density becomes less and the water rises to the surface. Here, as we all know, is the only place where the temperature can reach the freezing point, and where, no matter at what point the refrigerant may be applied, ice only can form. With this invariable result before us, it is certainly not rational to ignore the influence of much greater variations.

The difference in density, however, is not the only result of these thermal variations; nor possibly the chief. Evaporation, as well, is a most powerful agent in causing circulation, and this is a direct result of both temperature and the hydroscopic condition of the atmosphere. Take, for instance, the Mediterranean Sea. Mr. Smellie tells us that this is an excellent confirmation of his rotation theory, but he has omitted the consideration of an important fact, which has been established by no less an authority than Sir Charles Lyell. The temperature of the waters of this inland sea is fully 11° C. above that of the outer ocean, and this, together with the prevalence of the hot desiccating winds from the Sahara, makes the evaporation excessive. There are, it is true, two currents flowing through the Straits of Gibraltar in opposite directions, but it is the eastward current which has the greater volume, for the evaporation exceeds the supply from the tributary rivers, and the deficiency must be made good by the Atlantic. This is an admirable case in point, for here the two forces, evaporation and the lagging resulting from the earth's rotation, are acting in opposition, and it is the influence of evaporation which predominates.

Again, were the influence of rotation as powerful as it is represented by its advocates, we might expect to find that the ocean on the eastern side of a continent would have a level slightly superior to that on the western coast; and of the two hemispheres, America would present the ideal conditions for which we are seeking, for here we have an unbroken continent stretching from the Arctic circle to Cape Horn, and receiving the full force of the equatorial current. But

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* Alfred Maury, Histoire des Religions de la Grece Antique, vol. i., p. 106.

* Herodotus, lib. ii., 46.

‡ Herodotus, lib. ii., 145.

§ Brasseur de Bourbourg, Introduction to the Work of Landa, "Las Cosas de Yucatan," p. lxx.

‖ Sir Gardner Wilkinson, Manners and Customs of Ancient Egyptians, vol. iii., p. 41.

* Lizana, Historia de Nuestra Senora de Izamal, part i.

† Cogolludo, Historia de Yucatan, lib. iv., chap. viii.

‡ Sir Gardner Wilkinson, Manners and Customs, vol. iii., p. 34.

§ Sir Gardner Wilkinson, Manners and Customs, vol. iii., p. 35.

‖ Bunsen, Egypt's Place in Universal History, vol. v.; Dictionary of Hieroglyphs.

¶ Bishop Landa, "Las Cosas de Yucatan;" alphabet, p. 322.

** Troano MS., part ii., plate x.

* Pedro Beltran de Santa Rosa, Arte y Vocabulario de la Lengua Maya, p. 180.

† Greek Lexicon, Liddell and Scott.

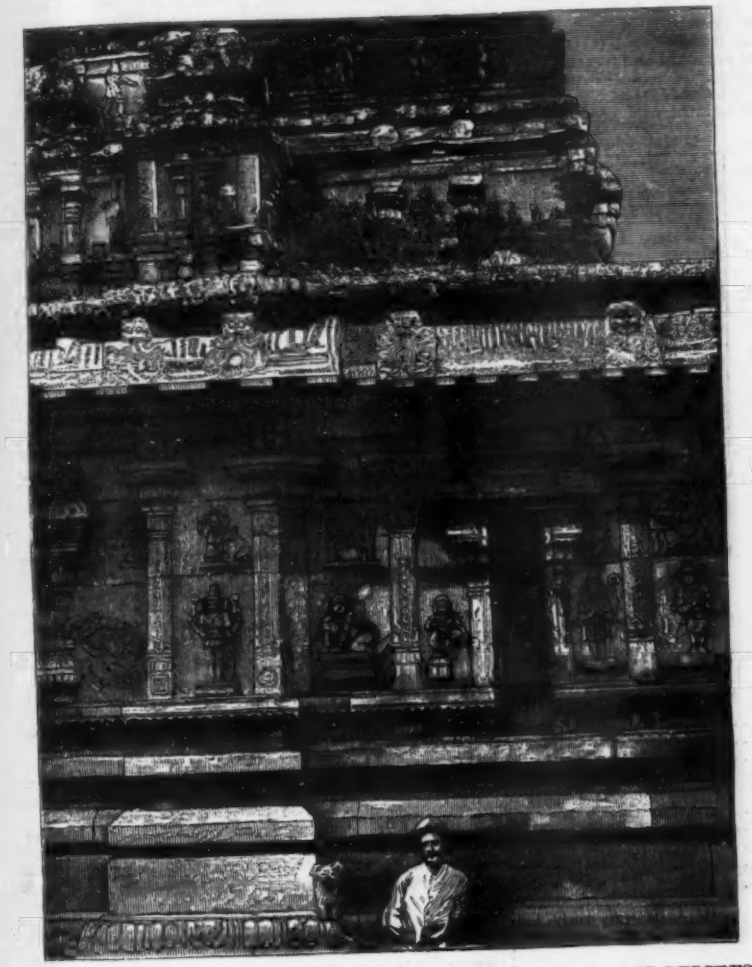
in point of fact we find that, if anything, the reverse is the case. The Panama Canal surveys, which are of undoubted accuracy, show a difference of level between the termini of eleven feet in favor of the Pacific side. Part of this discrepancy is ascribed to topographical and tidal influences, but the fact remains that the rotary lagging exercises no perceptible influence.

These are but fragments out of a large mass of natural evidence, but they seem sufficient to show that the influences of rotation are by no means so powerful as they have been represented. It is to a combination of many forces that one must look for the true cause of currents in both ocean and atmosphere.

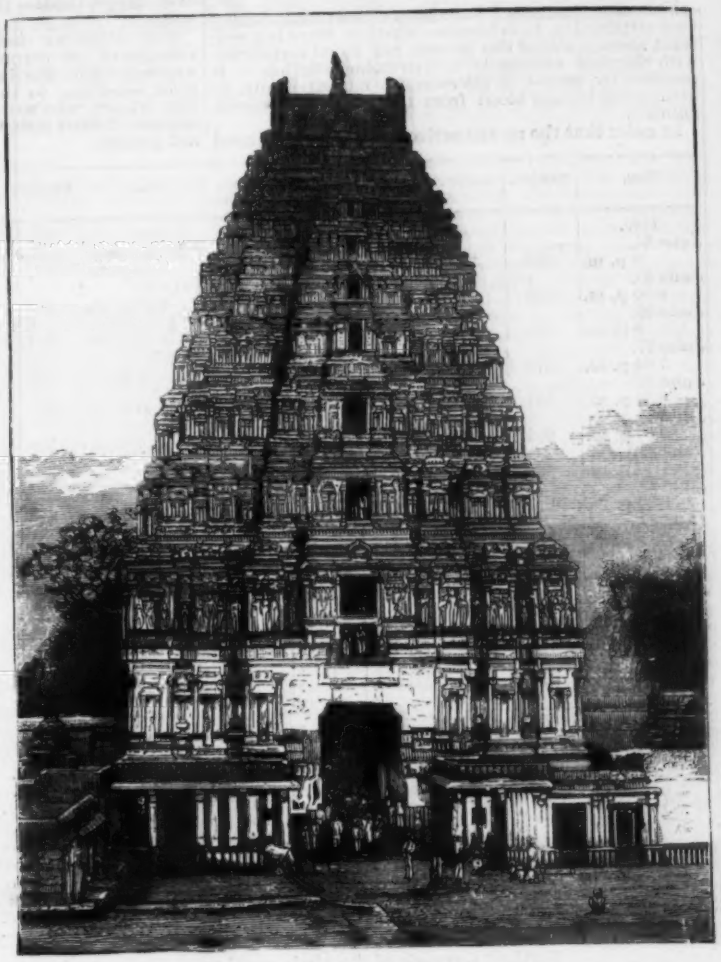
THE RUINS OF HUMPI, MADRAS PRESIDENCY.

OUR engravings are from photographs by Mr. George Avenel Breithaupt, Bank of Madras, Mercara, who writes: "My photographs represent the ruins of Humpi, some of, or, I should say, *the* most ancient temples in India. Natives from all parts of India flock to these ruins once a year to perform religious ceremonies, and there are constant parties of officers and government officials who travel to inspect these ruins. I have known Europeans come three to four hundred miles to see these far-famed Humpi temples. Humpi is about thirty-five miles from the large military station Bellari. Hitherto it has only been accessible by bullock coach from Bellari, but the new Bellari-Hoobli railway will facilitate this journey for the future.

"The second illustration shows the walls of one of the temples, which consist of bass-reliefs from the



THE WALLS OF ONE OF THE TEMPLES, SHOWING THE BASS-RELIEFS.



BISHTAPIAH GOPARA.

"VITLA ROYA" TEMPLE.

RUINS AT HUMPI, MADRAS PRESIDENCY, SOME OF THE MOST ANCIENT TEMPLES IN INDIA.

Ramayana of Hindoo mythology, and are receiving special attention from Government in the way of repairs, etc.

"Humpi covers a large area, some of the ruined temples being one and even two miles from each other, so that it takes a few days to go over and inspect the ruins carefully."—*London Graphic.*

MEASUREMENT OF BLOOD CORPUSCLES.

By Marshall D. Ewell, M.D.

For some time past I have been endeavoring, for my own satisfaction, to determine whether there is a constant average size of the human red blood corpuscles, with the view ultimately to determine whether it is possible, by means of micrometric measurements, to distinguish human blood from the blood of domestic animals.

In order that the results arrived at may be compared with those of other observers, I think it proper to state at the outset the methods and instruments employed.

The first requisite is obviously a correct standard of length, and the accurate determination of the value of the eye-piece micrometer used. This preliminary work has engaged much of my time and attention for several months past, and I have fully succeeded in obtaining two very accurate standards. The one of these which has been used as the standard of the measurements hereinafter given consists of lines ruled by Prof. W. A. Rogers, of Cambridge, Mass. (who is recognized as the highest authority upon questions of this sort), upon speculum metal at intervals of 1-2000 inch. The relative and absolute corrections of this standard have been determined by Prof. Rogers with very great accuracy, and the value of a division of the eye-piece micrometer described below was determined by taking an arithmetical mean of a long series of measurements of different intervals of 1-2000 inch, so as to eliminate, as nearly as possible, all errors of graduation and of measurement, and the value of one division of the micrometer was thus found to be 0·0000000925, or approximately 1-1000000 inch. The stand used, with mechanical stage and Abbe condenser, was made by Mr. Walter H. Bullock, of this city, and is of the pattern styled by him the "Biological Stand."

The actual tube length was 8·91 inches from end of nose-piece to upper end of draw-tube.

The cobweb eye-piece micrometer used was also made by Mr. Bullock, the pitch of the screw being ½ millimeter, and the micrometer head being divided into 200 parts, which were read to 1-10 of a division.

The objective used was a homogeneous immersion 1-10, made by H. R. Spencer, of Geneva, N. Y., having a numerical aperture of 1·35, and it was used with a Bausch & Lomb achromatic amplifier, giving an amplification of about 1,500 diameters. The immersion fluid used was Prof. Smith's new homogeneous immersion fluid, the composition of which he has not yet made public.

The blood was drawn from my finger, and a thin film spread with a needle upon the side of a cover glass from 0·150 to 0·165 of a millimeter in thickness, and examined at once, a fresh sample being used upon each occasion. It was examined with central illumination, and always under as nearly the same conditions as possible. During the first four days of the examination, I took, night and morning, about one drachm of the elixir of calisaya, iron, and strychnia; during the rest of the time no drug was taken, and the conditions were nearly identical each evening. From 25 to 100 corpuscles were examined each evening, and I have tabulated the results, giving the smallest, largest, and average size in millionths of an inch of each 25 corpuscles; also the average of each 50, 75, 100, and 200 corpuscles. The corpuscles were measured large and small, as they presented themselves in the field of the microscope, the only condition being that they should be approximately circular.

An examination of the following figures shows that the difference between the greatest and the smallest averages of 25 corpuscles is 0·000028 or 1-35714 inch, a magnitude that may be easily measured by any person having the requisite skill and apparatus.

The difference between the highest and lowest averages of 50 corpuscles is 0·000015 or 1-66666 inch, which approaches more nearly the limit of micrometric measurement, though probably not beyond it.

The difference between the highest and lowest averages of 75 corpuscles is 0·000012 or 1-83333 inch, which approximates the limit of micrometric measurement.

The difference between the highest and lowest averages of 100 corpuscles is 0·000009 or 1-111111 inch, which is within the limits of personal and instrumental error, according to the highest living authority upon this subject, who writes in substance, that it is easy to measure 1-50000 inch, but to be sure of 1-100000 inch is not possible.

Date.	Smallest.	Largest.	Average of each 25.	Average of each 50.	Average of each 75.
1885.					
June 24, 9 p. m.	260	368	(1) 313		
June 25, 8:30 p. m.	263	371	(2) 319	(1) 316	
June 26, 8 p. m.	274	383	(3) 335		(1) 322
June 27, 7:40 p. m.	270	361	(4) 320	(2) 327	
June 27, 8:55 p. m.	258	369	(5) 325		
June 28, 8:05 p. m.	286	349	(6) 316	(3) 321	(2) 320
June 29, 7:20 p. m.	286	384	(7) 329		
June 29, 8:20 p. m.	279	380	(8) 327	(4) 328	
June 30, 9 p. m.	274	361	(9) 318		(3) 325
July 2, 8:25 p. m.	271	355	(10) 330	(5) 319	
July 2, 9:15 p. m.	297	366	(11) 329		
July 2, 9:45 p. m.	266	348	(12) 318	(6) 323	(4) 322
July 7, 8 p. m.	274	349	(13) 313		
July 7, 8:45 p. m.	267	361	(14) 312	(7) 313	
July 7, 9:35 p. m.	273	380	(15) 315		(5) 313
July 7, 10:10 p. m.	284	345	(16) 313	(8) 314	
July 9, 8 p. m.	275	361	(17) 315		
July 9, 3:40 p. m.	278	350	(18) 312	(9) 313	(6) 313
July 9, 9:15 p. m.	198	393	(19) 317		
July 9, 10 p. m.	274	389	(20) 322	(10) 319	
July 11, 7:20 p. m.	278	348	(21) 318		(7) 319
July 11, 7:53 p. m.	255	363	(22) 307	(11) 313	
July 11, 8:37 p. m.	285	358	(23) 318		
July 11, 9:36 p. m.	288	356	(24) 328	(12) 323	(8) 318
July 17, 7:45 p. m.	285	349	(25) 314		
July 17, 8:40 p. m.	269	351	(26) 312	(13) 313	

Average of each 100: June 27, 7:40 p. m. ..... (1) 322.
" " " " " 29, 8:30 " ..... (2) 424.
" " " " July 2, 9:45 " ..... (3) 321.
" " " " " 7, 10:10 " ..... (4) 315.
" " " " " 9, 10:00 " ..... (5) 316.
" " " " " 11, 9:36 " ..... (6) 318.
" " " 200 June 29, 3:20 " ..... (1) 323.
" " " " July 7, 10:10 " ..... (2) 318.
" " " " " 11, 9:36 " ..... (3) 317.

Average of whole number (650) ..... 0·0003186 inch.
Correction for excess of value of micrometer..... 0·0000023

0·0003163=1-3162 inch.

Smallest corpuscle of the whole number..... 0·000198=1-5050 "
Largest corpuscle of the whole number..... 0·000393=1-2544 "

The conclusion to be deduced from the above figures is obviously that when a sufficient number of corpuscles are measured, there appears to be an average size, which varies within very narrow limits, which may possibly be accounted for or at least is consistent with personal and instrumental errors; for, though I have carried out the figures to the sixth decimal place, I have not the presumption to declare that the result can be relied upon farther than the fifth place, and have carried out the figures to the sixth only to insure accuracy in the fifth so far as possible. Another conclusion is, that granting for the moment that it is possible to identify blood by measurements of the red corpuscles, of which I am by no means satisfied, it is reckless in the last degree, if not criminal, to express an opinion upon the measurement of less than 100 corpuscles. To express an opinion upon the measurement of only 10 corpuscles, as I am informed has been done in this section within the last year or two, to take the most charitable view of the subject betrays such culpable ignorance of a subject involving such momentous consequences as ought forever to invalidate the testimony of one who should swear so recklessly. In a case involving the issue of life and death, it would be better to measure several hundred copuscles.

An examination of the unabridged table of measurements, from which the above summary is tabulated, discloses the further fact that by selecting the corpuscles, it would be possible for a dishonest observer to make the average much larger or smaller than the above given, without the possibility of detection; a fact, the bearing of which upon the value of expert testimony upon this subject is so obvious as to need no comment.

It will be seen that I have not attempted to draw any inference as to the cause of the larger average size of the corpuscles first measured. Whether it was due or not to the drugs exhibited during the beginning of this work is an interesting subject of inquiry, which must be reserved for future examination. I expect to continue these investigations, and at some future day will publish the results.—*Chicago Legal News.*

PRINCIPLE OF MAXIMUM WORK.

The following abstract is given in the *Journal of the Chemical Society* of a paper by Berthelot (*Bull. Soc. Chim.*) 43, 265–272: "The principle of maximum work reduces the phenomena of chemical change to two fundamental data—the one, the heat evolved in the reaction taken by itself; the other, the heat change resulting from the dissociation of the reacting substances. Although it cannot at present be definitely stated that an absorption of heat never results from chemical action, yet such an absorption always results from a decrease of energy, brought about by dissociation of the original substances or their derivatives, or from a change of physical state and specific heat. These phenomena of dissociation, fusion vaporization, and in general physical changes, result from the temperature required for the chemical action; thus, chemical affinity, in so far as it is measured by the heat disengaged, is expressed by the sum of two terms, the one a constant, or the heat disengaged at 273 deg., the other variable with the absolute temperature. The latter function of the temperature can only acquire a certain value in cases in which dissociation has commenced, whether of the initially reacting substances or of secondary compounds, such as hydrates, acids, or double salts. Although this condition of dissociation is essential for the production of chemical equilibrium, yet it is further necessary that it should give rise to a cycle of reversible changes, such as the double decomposition between the metallic chlorides, bromides, and iodides. Thus the author has shown that whether potassium bromide reacts with silver chloride, or silver bromide with potassium chloride, there is equally an evolution of heat—an observation confirmed by Potilitzin, who has proved that bromine can replace, to a certain degree, its equivalent of chlorine in metallic chlorides. These reversible phenomena are due to the production of metallic perbromides and chlorobromides, the existence of which explains the difficulty experienced in the complete displacement of bromine by chlorine. At low temperatures the action of bromine on chlorides is always accompanied by an evolution of heat."

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